SCIENTIFIC AMERICAN SUPPLEMENT. No. 1190

Copyright, 1898, by Munn & Co.

Scientific American, established 1845.
Scientific American Supplement, Vol. XLVI, No. 1190. NEW YORK, OCTOBER 22, 1898. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

GHOST DANCE.—I.*

THE recent fighting at Bear Island, in Northern Minnesota, between a small band of hostile Chippewas and a detachment of the Third Infantry, in which Major Wilkinson and five troopers were killed, demonstrates that the possibility of trouble with Indians is by no means passed. While in the case of the Chippewas the hostiles are said to have numbered only nineteen, our ignorance of the workings of the Indian mind renders even a small outbreak a serious matter, for we can only guess the motives which bring it about, and we are very apt to seize the most apparent motive, such as some local grievance, and attribute the trouble to that.

Thus the Ghost Dance excitement of 1890, perhaps the most widespread feeling which has ever affected such a large number of Indians, was not understood at the time, nor in fact for many years after, until an ex-

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT by Cosmos Mindeleff.

THE GHOST DANCE—LARGER CIRCLE.

SMOHALLA CHURCH ON YAKIMA RESERVATION.

haustive study was made by Mr. James Mooney, of the Bureau of American Ethnology, of the Smithsonian Institution, whose elaborate report appears in a recent annual report of that institution. The tribes affected by the curious beliefs which produced the Ghost Dance comprised almost all the Indians on reservations west of the Mississippi River, except those in the eastern part of Indian Territory, the Apache and Pueblo stocks in the south, the tribes of the extreme Northwest, and, oddly enough, the Chippewas of North Dakota and Minnesota. Curiously, also, it is found that the Ghost Dance religion is not a new thing, but merely a new application of an idea almost as old as human thought—the revival of a golden age of the past, and the coming of a messiah.

A lost paradise is the world's dreamland of youth. Every people, every tribe, has its traditions of a golden past, and as the conditions of the present are always more or less trying, the past is more and more glorified. Especially is this true of a decadent or decaying people, as has been forcibly demonstrated in the recent war with Spain. But human nature is much the same everywhere, be the man Spaniard, American, or Indian, and the human mind works along the same lines, differing only in degree, not in kind. A people who are growing and developing can push steadily forward, with gaze fixed eagerly on the future, cherishing the past only as a pleasant memory; but a nation which has passed its prime, and sees nothing but gloom ahead, gazes backward to its golden past, and exalts and glorifies that past in proportion to the misery of the present.

Out of this feeling has grown a belief, perhaps the most widespread which has ever taken possession of the human mind, the belief in a messiah. When a race lies crushed and groaning beneath an alien yoke, what is more natural than the dream of a redeemer who shall return from exile or awake from some long sleep to drive out the usurper and win back for his people what they have lost. The hope becomes a faith, the faith a creed of priests and prophets, and the dream a religion looking to some great miracle of nature for its culmination. The doctrines of the Hindu Avatar, the Hebrew Messiah, who, it will be remembered, was to be a temporal sovereign, the Christian millennium, the Hesunanin of the Indian Ghost Dance, and a hundred others, are essentially the same, and have their origin in a hope and longing common to all humanity, although strongest in humanity oppressed.

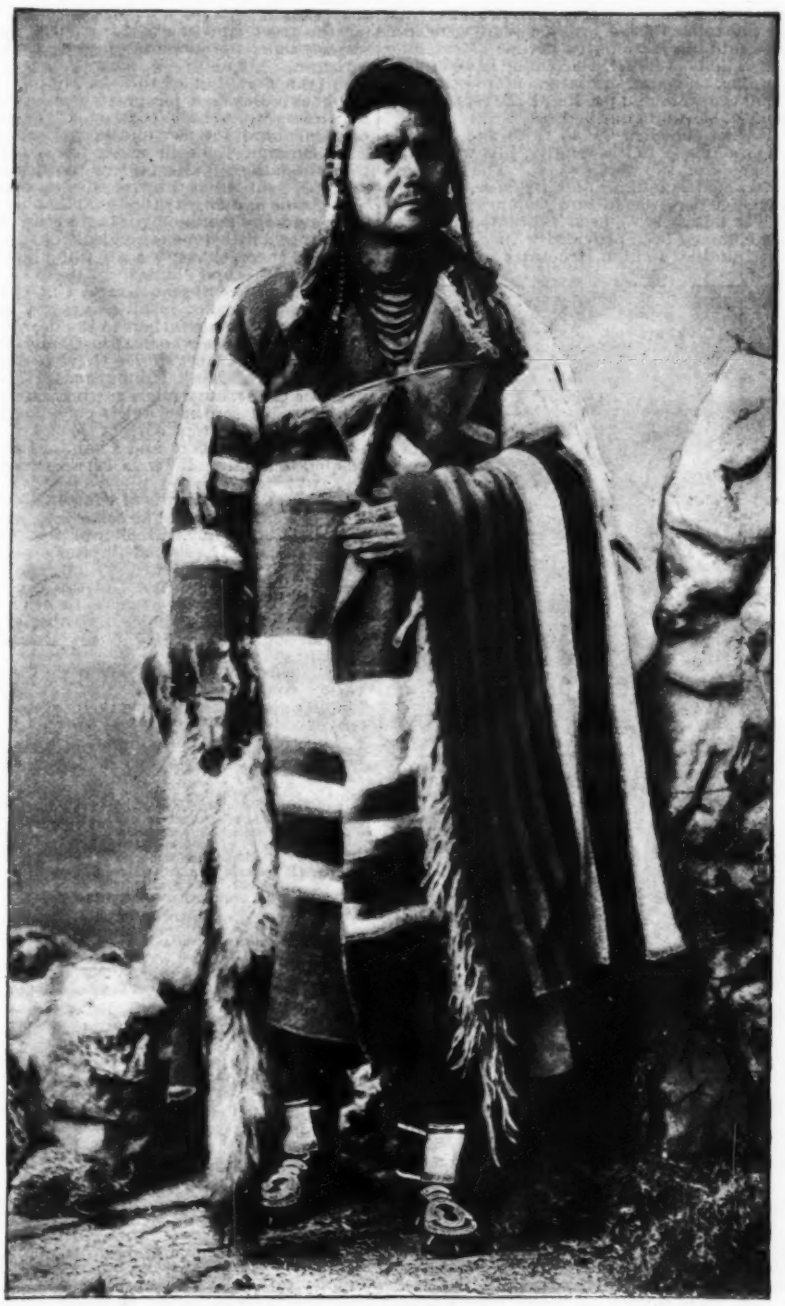
Probably every Indian tribe had its early hero-god, the great teacher, sometimes the great doer of all first things. In the words of Prescott, "Under him the earth teemed with fruits and flowers without the pains of culture. An ear of Indian corn was as much as a single man could carry. The cotton as it grew took of its own accord the rich dyes of human art. The air was filled with intoxicating perfumes and the sweet melody of birds. In short, these were the halcyon days which find a place in the mythic systems of so many nations in the Old World. It was the golden age of Anahuac." When his work is accomplished the hero bids farewell to his people, whom he consoles with a sacred promise that he will one day return and resume his kingdom, and sails away to the sunrise in a magic boat or other magic conveyance. Oddly enough the culture-hero of many of the southern tribes

THE GHOST DANCE—PRAYING.

ARAPAHO GHOST SHIRT.

is described as a white man with a flowing beard, and it was this belief which opened the way to the Spaniards on their arrival in Haiti, Mexico, Yucatan, and Peru.

At first the white strangers were welcomed as the children or kindred of their long lost benefactor, immortal beings whose advent had been foretold by oracles and omens, whose glistening armor seemed woven from the rays of sunlight, and whose god-like weapons were the lightning and the thunderbolt. Even the overbearing demands of the strangers awakened no resentment, for may not the gods claim their own? Not until the most sacred things had been trampled under foot and all the feelings of the people been outraged did the people realize what had come to them, and that "instead of the children of an incarnate god they had welcomed a horde of incarnate devils." Then came the efforts to drive out the intruders and to remove from the land every vestige of their presence. The first organized attempt was the great revolt of the Pueblo Indians in 1680, in which every Spaniard in what is now New Mexico and Arizona was killed or driven out, but within thirteen years the whole country was again brought under the yoke. Notwithstanding the failure of that attempt and of many others since in other parts of the country, for more than three centuries the Indian has cherished the belief that some day the white man will be driven out, and that if every trace of his presence could be removed, the golden age of long ago will be restored. This belief is an essential part of the doctrine of the Ghost Dance.



CHIEF JOSEPH.

"Hear what the Great Spirit has ordered me to tell you: Put off entirely the customs which you have adopted since the white people came among us," said the Delaware prophet in 1762. The prophet preached a union of all the red tribes and a return to the old Indian life, which he declared to be a divine command revealed to him in a vision. The religious ferment produced by his exhortations spread rapidly from tribe to tribe until, under the guidance of the master mind of the celebrated chief Pontiac, it took shape in a grand confederacy of all the northwestern tribes to oppose the further advance of the English. The coast lands were lost, but behind the natural barrier of the Alleghanies Pontiac determined to make his stand. The story has been too well told by that great master of language, Parkman, to be recapitulated here. The death of Pontiac, a broken-spirited wanderer, who was cut down by a hired assassin of his own tribe, ended the attempt, but the idea underlying it did not die and it was afterward taken up by the great Tecumtha, or Tecumseh, and carried almost to a successful conclusion.

Forty years later, when both the British and the French forces gave place to the flag of the young republic, which had extended its domain to the foot of the Rocky Mountains, and when the Indians, after twenty years of incessant warfare under the leadership of Little Turtle, during which they twice rolled back the tide of white invasion, defeating two of the finest armies ever sent into the western country, finally met the conqueror at Greenville in 1795 and signed away the rights for which they had fought so long, another prophet rose among the Shawana, who, with the Delaware and the Wyandot, constituted the three leading tribes, and had been driven back as refugees among the Miami.

The prophet, who was then but thirty years of age, announced that he was the bearer of a new revelation from the Master of Life, who had taken pity on his red children and wished to save them from further destruction. He preached a return to the ancient customs, all property must be held in common according to the ancient law of their ancestors. Indian women must cease to intermarry with white men; the two races were distinct and must remain so. The white man's dress, with his flint and steel, must be put away; in short, every tool and every custom derived from the whites must be discarded, and the Indians must return to the methods taught them by the Master of Life. When they did this, he promised that they would again be taken into favor and find the happiness which their fathers had known before the coming of the whites. The words of the prophet aroused an intense excitement among his hearers, which spread from camp to camp, and from tribe to tribe. By some means he ascertained that an eclipse of the sun would occur in the summer of 1806, and predicting it successfully, he added immensely to his power over the people. It does not appear that the prophet advocated any hostile combination against the whites; they were to be destroyed by some great natural catastrophe, according to the belief of some by a terrible hailstorm, which would annihilate not only the whites but also the unbelieving reds, while the elect would be warned in time to save themselves. In 1807 the excitement became intense, and great crowds of Indians of many different tribes journeyed to the vicinity of Detroit, where the prophet resided.

It was at this time that there came upon the scene the heroic character in Indian history, the great Tecumtha, brother of the Shawano prophet, and one of the greatest leaders of men in the world's history. In the multitudes assembled at Greenville to listen to the teachings of the prophet he saw his opportunity, and he was quick to improve it, and what was at first a simple religious revival soon became a political agitation. The apostles of the prophet became recruiting agents for his brother, and a great conspiracy or confederacy was being organized when, in 1811, Gen. Harrison marched out at the head of 900 men to threaten Tippecanoe, the prophet's town, near Vincennes. In the absence of Tecumtha, who had gone on a long journey as far south as Florida to extend his propaganda, the Indians in their fortified town were under the command of the prophet, who, disobeying the explicit directions of Tecumtha, made an attack on the American forces at 4 o'clock on the morning of November 7, 1811, and were disastrously defeated. Tecumtha returned a few days later to find his followers scattered, his brother a refugee, and the great object of his life brought to nothing.

After this there were several minor prophets, in the decades that followed, notably one Kanakuk, who was prominent among the Kickapoo in 1827, but who attained no great vogue elsewhere; Long Nose, of the Winnebago, who was prominent in that tribe in 1852, and but little heard of outside of it; and Tavibo, who created some excitement among the Paiute of Nevada in 1870. Tavibo is said to have been the father of the "messiah" who produced the Ghost Dance excitement of 1890, and there is no doubt that the latter derived many of his ideas from Tavibo.

While the Paiute were preparing for the millennial dawn, reports became current of a new "dreamer prophet" on the Columbia River, who was known as Smohalla, and who was becoming a thorn in the flesh of the Indian agents in that quarter. As early as 1870, Agent Meacham reported that "One serious drawback (to the adoption of the white man's road) is the existence among the Indians of Oregon of a peculiar religion called Smokeller, or Dreamers, the chief doctrine of which is that the red man is again to rule the country, and this sometimes leads to rebellion against lawful authority." He asked for a military force to bring in a recalcitrant band of these Dreamers. In 1872 Smohalla's followers along the Columbia were reported to number 2,000, and his apostles were represented as constantly traveling from one reservation to another to win converts to the new teachings. Repeated efforts were made to induce them to go on the reservations in Eastern Oregon and Washington, but without success. The new prophet taught that a new god was coming to their rescue; that all the Indians who had died, or should die hereafter, were to be resurrected; that they would then be very numerous and powerful, able to conquer the whites, to recover their lands, and to live as free and unrestrained as their fathers did in olden times.

For several years little more was heard of Smohalla and his doctrines until they were again brought under notice by the growing dissatisfaction which culminated in the Nez Percés war of 1877. The Nez Percés, under the leadership of Chief Joseph, were largely under the influence of Dreamer prophets, and in the various conferences which took place between General Howard and the Indians prior to the outbreak of hostilities, the Dreamer priests acted as spokesmen for the latter. After the fighting of June 13 to July 12, 1877, in which 21 settlers and 58 soldiers were killed, the masterly retreat of more than 1,000 miles by Chief Joseph and his band—the most remarkable exhibition of generalship in the annals of Indian warfare—culminated in the final surrender to Colonel (now General) Miles, in October.

Little more was heard of Smohalla after the Nez Percés war until the opening of the Northern Pacific Railroad, in 1883, once more brought to a focus the land grievances of the Indians in that section, and gave new life to the teachings of the prophet, whose doctrines and rites spread from tribe to tribe, wherever they found congenial soil, until they covered practically the whole western third of the United States. In fact, it was Smohalla who kept alive these ideas for twenty years, thus furnishing the substratum upon which the "messiah" craze of 1890 rested. He was born in 1815 or 1820, and was therefore an old man in 1890, but he was well preserved and had lost none of his power as an orator, from which he derived his great influence. In his youth he had frequented a Catholic mission, and what he learned there is plainly visible in his own ritual performance. Although prior to 1860 he had established a local reputation as a medicine man, about that time an incident occurred which stamped him as a great prophet and changed the whole course of his life.

As a result of a quarrel with a neighboring chief, a fight ensued, and Smohalla was left upon the ground as dead; but he revived sufficiently to crawl to a boat on the Columbia River nearby, and to get into it. Far down below he was rescued by some white men, and, eventually, recovered; but, unwilling to return in disgrace, he resolved to become a wanderer, and went upon a journey or a series of journeyings, the most remarkable ever undertaken by an uncivilized Indian. Going down the Columbia to Portland and the coast, he turned south to various points in Oregon and California, and continued beyond San Diego to Mexico. Coming back he passed through Arizona, Utah, and Nevada, and finally reached his former home on the Columbia, where he announced that he had been dead and in the spirit world, and had returned, by divine command, to guide his people. As it was thought that he had been killed, his awe-struck hearers readily believed him, and he immediately acquired an immense influence in the tribe.

Smohalla declared to his people that the Great Chief above was angry with them, and commanded them to return to their primitive manners and customs. During his wanderings he had elaborated a detailed system of religion, with an elaborate ritual, based partly on primitive mythology or partly on what he had seen and on what he remembered of the Catholic ceremonial and military parades, and perhaps, also, with some additions from Mormon forms. This system he commanded his hearers to adopt. Smohalla was subject

to cataleptic trances, and claimed that, while he was in this unconscious condition, he received revelations. Unbelievers were allowed to experiment with him during his trances by sticking needles through his flesh, cutting him with knives, etc., and, as there was no responsive action, he was believed to be surely dead, because blood did not flow from the wounds. It is this going into long trances that gave rise to the title of "Dreamers," or believers in dreams, commonly given by surrounding tribes, as, after a trance, the most circumstantial details of visions are related.

The idea that the earth is the mother of all created things lies at the base, not only of the Smohalla religion, but of all primitive theology. Says Smohalla, "You ask me to plow the ground! Shall I take a knife and tear my mother's bosom? Then, when I die, she will not take me to her bosom to rest."

"You ask me to dig for stone! Shall I dig under her skin for her bones? Then, when I die, I cannot enter her body to be born again."

"You ask me to cut grass, and make hay, and sell it, and be rich like white men! But how dare I cut off my mother's hair?"

In 1881 there originated among the tribes of Puget Sound, in Washington, a new religion, not founded on prophecy, but worth special mention on account of the prominent place in its ceremonial which hypnotism occupies. There is good reason to believe that the Paiute messiah himself, and through him all the apostles of the Ghost Dance, obtained their knowledge of hypnotic secrets from the "Shakers" of Puget Sound. The sect were so called because of the large amount of nervous shaking which is part of the observance. They claim to heal the sick by faith and prayer. An instance which is described will serve to illustrate the method. Two doctors of the sect were called in to treat a woman who was very seriously ill. After an examination they announced that the evil had been put into her by the magic of a neighboring medicine man, whom they summoned into their presence. With cloths and lighted candles the two doctors approached the woman and commanded her to rise, which she did, although it had been supposed that she was too weak to stand. Waving the cloths in front of her, and blowing upon her at the same time, the doctors proceeded to drive the disease out of the woman's body, beginning at the feet and working upward. As they approached the head the principal doctor changed the movement to a rapid fanning, and corresponding blowing, while the other stood ready with a cloth to seize the disease when it should be driven out. All this time the medicine man standing a few feet away was shaking and quivering like one in a fit, and the trembling became more violent and spasmodic as the doctors increased the speed of their motions. Finally the leader brought his hands together over the woman's head, where, just as the disease attempted to escape, it was seized and imprisoned by the cloth held by the assistant. Then, going up to the medicine man, they fanned the disease into his body with a few rapid passes, and he fell down dead. This is the story as told by an Indian. The woman recovered and became an apostle of the new religion.

When Tavibo, the prophet of the Paiute, died about 1870, he left a son named Wovoka, who afterward became the messiah of the Ghost Dance religion. This young man, who was only fourteen years old when his father died, had never been away from the little valley in which he was born, and spoke only the Paiute language. He was taken into the family of a white farmer in the vicinity, and when about twenty years of age he married, but continued to work for the farmer. Four years before, when he was sixteen, he had given the dance to his people, but he had received the great revelation two years after that, in 1889 or 1890. On that occasion "the sun died," or was eclipsed, and he fell asleep in the daytime and was taken up to the other world. There he saw God, with all the people who had died long ago, engaged in their old time sports and pastimes, all happy and forever young. When the news of this vision got abroad, numerous delegations visited the new messiah, among them a large one from the Cheyenne and Arapaho, under the leadership of Black Coyote, who was an enthusiastic devotee of the cult.—For our engravings we are indebted to the courtesy of the Director of the Bureau of Ethnology, Smithsonian Institution. They are from the Fourteenth Annual Report of the Bureau of Ethnology.

RELATIVE VALUE AS DISINFECTANTS, ANTISEPTICS, AND DEODORIZERS OF REPUTED ANTISEPTICS.

A. Gawalowski (Pharmaceut. Post) has prepared a table, made from actual tests, showing the relative value of the various substances now in common use in the professions or on the market as antiseptics, disinfectants, and deodorizers, corrosive sublimate being assumed as the unit of comparison. We reproduce below the more prominent of the substances tested, with their values:

Substance.	Per Cent Solution	Disinfecting.	Antiseptic.	Deodorizing.
Sublimate solution	5	100	100	....
Carbolic acid	100	50	50	40
Sulphurous acid gas	.....	50	50	50
Thymol, solid	100	50	50	40
Creasote	100	50	50	40
Antimonium (Bayer)	100	50	50	40
Antimycelin (Gawalowski)	100	50	50	40
Iron sulphate, crystal	.....	40	50	30
Iron-zinc sulphate, crystal	.....	40	50	40
Iron oxide	.....	40	10	15
Iron-zinc-magnesium sulphate	.....	40	30	30
Copper-zinc sulphate	.....	35	40	40
Iron-zinc-copper sulphate	.....	35	35	40
Zinc phenolate, dry	.....	30	40	45
The sulphites	10	15	15	15
The same	40	25	25	25
Potassium permanganate	100	25	10	50
Potassium salicylate	100	25	25	25
Creolin	.....	25	25	40
Lysol	.....	25	25	40
Carbolate of lime	.....	2½-20	2½-20	3-15
Chlorine gas	.....	15	.....	80
Iron-zinc-calcium sulphate	.....	15	30	40
The ferri salts	50	10	10	5
Zinc salts, crystals	.....	10	.....	40
Calcium chloride	.....	5	.....	5

—National Druggist.

A CHIMNEY STRUCK BY LIGHTNING.

The fall of a thunderbolt upon a tall building is often attended with great catastrophe, or, at the least, with serious damage. To prevent such an accident, too many precautions cannot be observed. In fact, for houses located in districts that are frequently visited by storms, it is well to take particular measures.

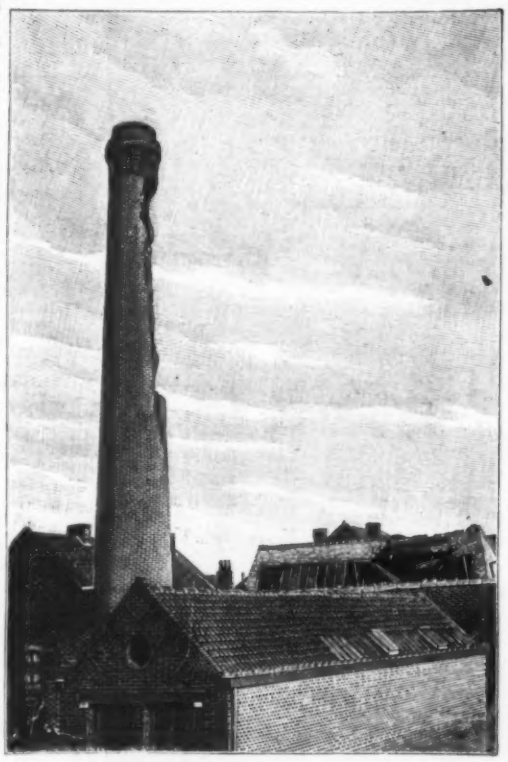
Lightning rods should be put up under proper conditions, and care be taken to keep them in good order. With much stronger reason should precautions be taken when it is a question of a high building exposed at every moment to atmospheric discharges. Apropos of this may be specially mentioned the chimneys of manufactories, which are always very high and provided internally with bars of iron to permit of reaching the summit, and which seem still further to expose the structure to lightning stroke.

We have a curious example of this in an accident that happened on the third of May to the works of Messrs. Ermen & Roby, manufacturers of glazed ware, at Armentieres, and photographs of which have been sent to us by Messrs. Battig and Colombier.

The works in question are situated in the very center of the city. The chimney was 98 feet in height and 33 feet in circumference at the base and provided with a crown at the top. In the interior there were iron rounds sealed into the masonry to permit of reaching the summit. The bolt struck the chimney externally above the coping, traversed the latter, entered the interior, ran along the wall, and produced the rent, nearly 40 feet in length, shown in our figure.

The bricks were detached on all sides and in their fall did much damage in the vicinity, just where the shops and depots of the works stood. The chimney, however, remained standing, and its base, up to a height of about 30 feet, was in nowise damaged.

This accident might have been prevented in great part had the chimney been provided with a lightning rod. It is certain that so high structures are often exposed to lightning stroke, and it is, therefore, well to take every measure of precaution necessary. It will be seen how dangerous it is to establish such a chimney in the center of a factory in the very heart of a city.



A FACTORY CHIMNEY STRUCK BY LIGHTNING.

M. Battig communicates a few data as to the reconstruction of the chimney, and which it appears was attended with considerable trouble. It was necessary in the first place to demolish the chimney brick by brick, and the attempt to ascend to the summit in order to do this presented difficulties.

These were surmounted by erecting in the interior a scaffolding formed of three ladders and some specially arranged planks. The coping was in the first place suddenly detached, and fortunately fell without carrying along the mason.

The construction was afterward carried on without hindrance. It will be seen that the simple striking of a chimney by lightning may lead to serious complications and cause manufacturers much loss and damage. All such accidents should serve as a lesson in the case of installations to be established.

For the above particulars and the illustration we are indebted to La Nature.

THE ASTRONOMY OF THE "CANTERBURY TALES."

By E. Walter Maunder, F.R.A.S., in Knowledge.

There is one subject of which men never tire. They are always willing to be told of the way in which other men in different circumstances, in other lands, or in past ages, lived; of their habits and thoughts. Those who can tell us with certainty and vividness these things about other men will always claim our attention, and because of all such narrators he is one of the freshest and most natural, old "Dan Chaucer, the first warbler," as Tennyson so aptly calls him, will never lack an audience.

There are other reasons for his popularity.

"Oh to be in England,
Now that April's there!"

was Browning's wish, and Chaucer ever takes us to England in the freshest, fairest blossom of a springtime, always young. A free-hearted contentment possesses him at all times:

"Sufficè thee, thy good, though it be small."

But more frequently this broadens out into a frank joyousness that refreshes us still, five hundred years after he has gone to sleep.

"Unto this day it doth mine hertë boote,
That I have had my world as in my time."

It is not, however, with Chaucer as a poet, or as a shrewd, observant, kindly man of the world, that I am now concerned. Like one of his friars whom he scathes so sharply, yet so amusingly, I have to keep within my "lymytatioun," and to ask him, not for the sweet scent of the hawthorn, nor for the joyous notes of the woodland birds, but for any information which he may have to give as to the astronomy of his time.

From a poet so natural, so absolutely unpedantic, living long before the invention of the telescope and the revival of learning, and in a poem the subject of which is the wayside talk, and free blunt banter of ordinary folk, one would not naturally expect to find a single astronomical allusion, nor, if we found any, that they should be accurate. Yet even in Tennyson, by far the most scientific of our modern poets, there are scarcely more astronomical allusions than there are in Chaucer.

On the first day of the month just past—"Saint Lubbock's Day"—a far greater pilgrimage than that which was "personally conducted" by the stout host of the Tabard Inn, set out from London and spread itself through Kent, in much the same direction as their forefathers, half a millennium before. But it may well be doubted if any of the modern company—nearer nine and twenty thousand than nine and twenty—brought any astronomy into their holiday talk, or, if perchance a little science did leak out in conversation here and there, that it was anything but vague, uncertain, and at second hand.

In spite of Board schools and University Extension lectures, we are not in all things the unquestionable superiors of our forefathers in the days of the Plantagenets. The men who deal in Chaucer's trade to-day—the writers of short stories—have multiplied as abundantly as our Bank Holiday makers have increased over the Canterbury pilgrims; but astronomy is carefully avoided by them unless perchance the hero has to be delivered from a tight corner by a total solar eclipse lasting an hour and a half, or the heroine to be treated to a sight of Venus between the horns of the crescent moon.

Chaucer's astronomy is of course of quite a different kind from any that would come into popular tales or conversation to-day. He knows nothing whatsoever of the spots on the sun, of Jupiter's belts, or Saturn's ring. His mind is vexed by no controversies as to whether the "gemination" of the canals of Mars is a real phenomenon or a mere function of imperfect focusing, and the nebular hypothesis, either in its gaseous or "meteoritic" phase, passes him by untouched.

Still, astronomy, real astronomy, enters into his verse; the astronomy of the day and year; it is familiar and actual both to the poet and to his characters.

Never did any poem open with a fuller, fresher breath of spring than the Prologue to the Canterbury Tales:

"Whanne [illegible]pril with his shoures sote
The droug[illegible] of March hath perced to the rote,
And bathed every veine in swiche licour,
Of whiche vertue engendred is the flour;
Whan Zephirus eke with his sote brethe
Enspired hath in every holt and hethe
The tendre croppes, and the yonge sonne
Hath in the Ram his halfe cours yronne,
And smale foules maken melodie."

It is Chaucer's habit to give his notes of time, sometimes by reference to the calendar, sometimes, as in the present passage, by the position of the heavenly bodies, the sun in particular. The eighth line in the above quotation has given rise to some unnecessary discussion. For in Chaucer's day the sun entered the sign Aries—not the constellation—about March 12. By the first of April, therefore, the sun would have passed through more than half of the sign of the Ram. But the first two lines seem to point to April being far advanced, since its "sweet showers" have "pierced to the root," the "drought of March." Later on Chaucer expressly tells us, in the Prologue to the "Man of Lawe's Tale," that it was then the 28th of April when the pilgrimage had nearly come to its close. We may therefore suppose that it is quite the middle of April when the poem opens, and that by the sun's "half course" in the Ram is meant the latter half of the sign, the half he passed through in the first fortnight of April, not the former half, which he passed in the last fortnight of March.

For it is clear from other passages that Chaucer quite understood when the sun entered Aries, for in the "Squier's Tale" we are told that Cambuscan—

"He let the feste of his nativitee
Don crien, thurghout Sarra, his citee,
The last Idus of March, after the yere.
Phebus the sonne ful jolif was and clere,
For he was nigh his exaltation
In Martes face, and in his mansion
In Aries, the colerike hote signe;
Ful lusty was the wether and benigne,
For which the foules again the sonne shene,
What for the season, and the yonge grene,
Ful loude songen hir affections;
Hem semed han getten hem protections
Again the swerd of winter kene and cold."

The Ides of March fell on the 15th. For the following day we have a further note of time. The sun has entered Aries four degrees, that is, four days.

"Up riseth freshe Canace herselve,
As rody and bright, as the yonge sonne,
That in the Ram is foure degrees yronne
No higher was he, whan she redy was,
And forth she walketh esily a pas,
Arrayed after the lusty seson sote."

So again in the "Nonne Preste's Tale" we have a day in May marked out for us in two ways, first by the calendar, next by the position of the sun in Taurus—

"Whan that the month in which the world began
That highte March, whan God first maked man,
Was complete, and ypassed were also,
Sithen March ended, thritty dayes and two.

. . . . . .

Cast up his eyen to the bright sonne,
That in the signe of Taurus had yronne
Twenty degrees and on, and somewhat more:
He knew by kind, and by non other lore,
That it was prime, and crew with blisful steven,
The sonne, he sayd, is clomben up on heven
Twenty degrees and on, and more ywis.
Madame Pertelote, my worides blis,
Herkeneth thise blisful briddes how they sing,
And see the freshe floures how they spring."

Chaucer here evidently means that the sun entered Taurus about April 11; hence it would enter Aries March 19; but the exact day would vary of course with the position of the year with regard to leap year.

The knowledge of the sun's longitude day by day throughout the year strikes us as strange and unusual. But the above quotations, especially from a work so entirely natural and descriptive as the "Canterbury Tales," show us how very general was the knowledge at the time, and is a clear indication that the sun's movements were both followed observationally with considerable diligence, and were published freely up and down the country in works to which many had access. Probably the great popularity of the universities at the time, the attendance at which was, relatively to the entire population, something like fifty times what it is at present, had much to do with the wide diffusion of knowledge of this kind.

Another relation in which astronomy is introduced is a more practical one. The need to be able to tell the time of day has caused men in countries and in times when clocks and watches are unknown or little used, to pay much more attention to the daily movements of the sun than we do. He still, of course, remains our great timekeeper; but there are so few who now resort to him directly for the information that his service in this connection is quite forgotten by the great majority.

It was not so in Chaucer's day. Then the sun dial, or, failing that, a rough estimation of the sun's altitude, was the means for telling the hour. In the Prologue to the "Persone's Tale," Chaucer gives us the method by which he concluded that it was four o'clock, and a little calculation shows that he was sufficiently correct.

"By that the Manciple had his tale ended,
The sonne fro the south line * was descended
So lowe, that it ne was not to my sight
Degrees nine and twenty as of hight.
Foure of the clok it was tho, as I guess,
For eneleven foot, a litel more or lesse,
My shadow was at thilke time, as there
Of swiche feet as my lengthe parted were
In six feet equal of proportion."

Nor was Chaucer alone able to make such a calculation. The host of the Tabard, though "not depe expert in lore," could work out a similar but simpler problem.

"Our hoste saw wel that the brighte sonne
The ark of his artificial † day had ronne
The fourthe part, and half an houre and more;
And though he was not depe expert in lore,
He wiste it was the eighte and twenty day
Of April, that is messager to May;
And saw wel that the shadow of every tree
Was as in lengthe of the same quantitee
That was the body erect, that caused it;
And therfore by the shadow he toke his wit,
That Phebus, which that shone so clere and bright,
Degrees was five and fourty clombe on hight;
And for that day, as in that latitude,
It was ten of the clok, ‡ he gan conclude."

It is in these two particulars, the apparent progress of the sun along the ecliptic during the year, and his course across the sky during the day, that astronomy entered chiefly into men's lives in Chaucer's day. There was as yet no suspicion that the earth was not the fixed center of the solar system, or that the apparent motion of the sun along the ecliptic was due to the real motion of the earth. Ptolemy was still the master mind of astronomy.

"Of alle men y blessed mote he be,
The wise astrologien Dan Ptholomee,
That sayth this proverbe in his Almageste:"

As with Dante, the planets revolved for Chaucer in successive crystalline spheres, for Europe had still two centuries to wait for Copernicus.

"And by his eighte speres in his working,
He knew ful wel how far Alnath was shove
Fro the hed of thilke fix Aries above,
That in the ninthe spere considered is."§

But, though he gives us evidence enough that the commonalty believed in astrology more or less, he himself and the better classes had quite broken off from it. The "Chanones Yemanne" tell us—

"Sol gold is, and Luna silver we threpe;
Mars iren, Mercurie quicksilver we clepe:
Saturnus led, and Jupiter is tin,
And Venus coper by my fader kin."

But this is only the trade jargon of a confessed charlatan. The wife of Bath gives astrological reasons why learned men have little estimation for women, but is scarcely more serious in her argument than in her quotations from St. Paul.

"The children of Mercury and of Venus,
Ben in hir werking ful contrarious.
Mercury loveth wisdom and science,
And Venus loveth riot and dispence,
And for hir divers disposition
Eche falleth in others exaltation.
As thus, God wote, Mercury is desolat
In Pisces, wher Venus is exaltat,
And Venus falleth wher Mercury is reised.
Therfore no woman of no clerk is preised."

But the Frankeleine disposes of astrology or "magike naturel" in a very off-hand manner, though he describes the work of an astrologer in much detail.

"Which book spake moche of operations
Touching the eight and twenty mansions ‖
That longen to the Mone, and swiche folie,
As in our dayes n'is not worth a flie.
. . . . . .
"His tables Toletanes * forth he brought
Ful wel corrected, that ther lacked nought,
Nother his collect, ne his expans yeres,
Nother his rotes, ne his other geres,
As ben his centres and his argumentes,
And his proportional convenientes
For his equations in everything.
. . . . . .
"Whan he had found his firste mansion,
He knew the remenant by proportion;
And knew the rising of his mone wel,
And in whos face, and terme and every del;
And knew ful wel the mones mansion."

Such was astronomy in Chaucer's day, very narrow and confined, without a hint of those wonderful revelations which the telescope and the spectroscope have brought to us, without a guess at that majestic order of which Copernicus had the first faint vision, which unfolded itself in three-fold stages to Kepler, and gave itself in the fullness of its completeness to Newton.

Yet, narrow as it was, hampered as it further was by its connection with the bastard science of astrology, already falling into merited contempt, astronomy had a real existence in Chaucer's time; real because a science of actual observation. Englishmen of that time lived out of doors, they were cooped up in no great cities, the sun himself was their great almanac and clock, and they were obliged to learn how to read him. That which they were able to learn from Nature may not have been much, but, at least, they learned it first hand.

Exactly the opposite condition of things prevails to-day. Immense volumes of knowledge have been opened to us of which our forefathers never dreamed; and the Press secures the ready and wide diffusion of every fresh advance. Yet there can be no doubt that in some respects a practical personal acquaintance with Nature is less general now than then. We may be quite sure that in Chaucer's day the veriest clodpole knew that the stars rose and set. There are probably millions in England who do not know it to-day; Sir George Airy thought it not safe to assume that even Cambridge undergraduates knew it.

There is a knowledge of science, of a sort, very widely spread to-day, but the utter nonsense which is often calmly printed in newspapers, and far more often inserted in popular stories, proves how thoroughly second-hand it is. Such knowledge as that possessed by Tomlinson, of Berkeley Square,

"This I have read in a book, he said;
And this was told to me;
And this I have thought that another man thought,"

is indeed better than nothing; but far better still is it to base one's knowledge upon one's own observations, one's own experiments, however crude, and to learn, not from books alone, but from the lips of Nature herself.

* The meridian, that is to say.

† "His artificial day," i. e., his mean day, from six in the morning to six in the evening, as contrasted with his natural day, from sunrise to sunset.

‡ It would be nearly a quarter to ten, apparent time, corresponding to the "fourth part" of the daily arc, "and half an hour and more."

§ In other words, he knew the distance of the first star in Aries, the actual constellation, from the first point of Aries, the zero point of celestial longitudes. The actual stars and constellations are considered to be in the eighth sphere; the equal signs of the zodiac, the divisions of celestial longitude, in the ninth; the different planets occupying the first seven.

‖ Of the lunar zodiac.

* The Alphonsine Tables.

RADIOGRAPHIC NOVELTIES.

IN a fine work recently published in England, Prof. J. J. Thomson endeavors to demonstrate that various gases, submitted to an electric discharge in a Crookes tube, can be brought to such a state that the quantity of electricity carried off by each particle is constantly proportionate to the mass of each of the small projectiles that escape from the surface of the cathode. He concludes therefrom that all the gases with which his experiments were tried can be dissociated to such a degree that the ultimate particles thus obtained shall be identical with each other.

According to this, we find realized for the first time the division of matter into its ultimate elements, which are found to be all alike, as a large number of scientists had already considered them to be. The reasoning seems to be infallible, and the result is one of the most wonderful that science has brought to light in recent years; and yet the memoir of the learned scientist has passed almost unnoticed. Are physicists in general ignorant of it, or are they waiting for a confirmation of its conclusions? But little has been said about it, and it seems that at present it is well for us to be reserved.

M. Villard, in fact, has just given Thomson's experiment an interpretation different from that of its author, and from which it is difficult to escape.

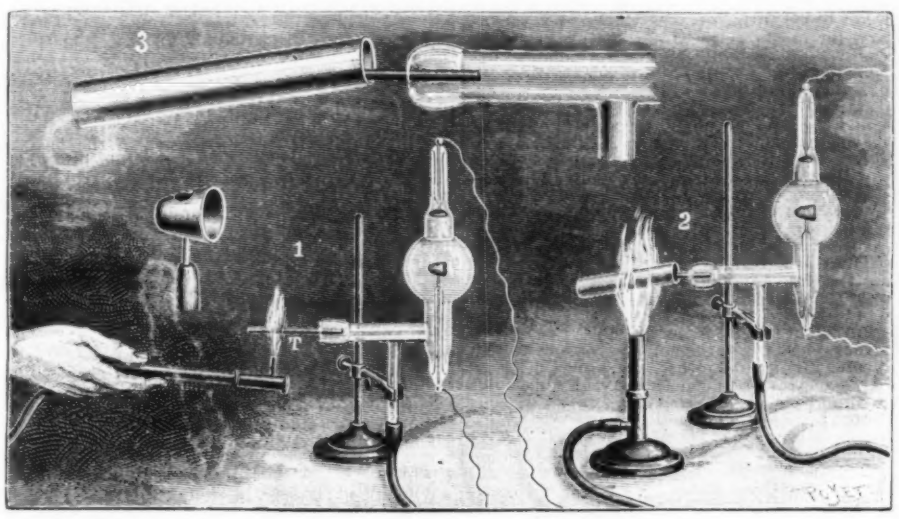
Numerous experiments, which were as decisive as they were varied, having shown M. Villard that cathodic rays have always a reducing effect, he asked himself to what the latter is to be attributed, and, carrying his investigations still further, he demonstrated that it is always due to the presence of hydrogen in the cathodic pencil. Furthermore, he admits that the rays that escape from the cathode are formed wholly of hydrogen.

The source of this gas is not difficult to discover, the walls of the glass being always covered with an extremely thin stratum of water, which, so to speak, can never be completely eliminated, and which, through its decomposition, furnishes hydrogen almost indefinitely. This idea is corroborated by the impossibility, recognized by M. Villard, of obtaining cathodic rays in a tube with mercury electrodes that has previously been exhausted over boiling mercury.

This property of hydrogen having been put out of doubt, M. Villard at once utilized it for the regeneration of the tubes already too much exhausted by the passage of the current. Hitherto, one has been content to disengage the gas necessary for the proper operation of the apparatus either from the sides of the glass or from a parasitic electrode. M. Villard's idea is different. He causes gas to enter from the exterior, in taking as a basis the fact pointed out by H. Sainte-Claire Deville (in some researches made in conjunction with M. Troost) that hydrogen diffuses itself through platinum heated to a bright red and passes with great rapidity through a thin plate of this metal.

The new Crookes tube constructed, with the assistance of M. Chabaud, is provided with a platinum tube, T, closed at its extremity and debouching in a lateral tubulure (No. 1). After the tube has become too hard, it suffices to heat the platinum in the reducing flame of a gas burner in order to have it become (in a few seconds) more manageable.

One of the advantages of the new process consists in the fact that it may be applied while the Crookes tube is in service, on the sole condition that the burner be carried by an insulating cylinder. It is so efficacious that an operator with slight experience will almost always exceed the point at which the tube gives the greatest abundance of X rays. The trouble is, fortunately, easy to surmount. The excess of gas, which is prejudicial to the proper operation of the apparatus, will pass off, just as it entered, through the reversal of the same phenomenon. It suffices, in fact, to surround the tubulure with a platinum ring that is raised to a



VILLARD'S NEW RADIOGRAPHIC TUBE.

1. Introduction of the gas. 2 and 3. Exhaustion of the tube.

red heat (Nos. 2 and 3), in order that a vacuum, as perfect as may be desired, may gradually form again.

Naturally the escape of the gas is much slower than its entrance, since the conditions of its density in the two cases are very different. It requires an hour or two to repair the damage done in a few seconds; but the tube will be saved.

This experiment shows in a very evident manner that hydrogen diffuses itself through platinum up to the very last trace, while the other gases of the atmosphere are arrested at the surface.

Another improvement, but of less importance, made by M. Villard, consists in giving the platinum anticathode the form of a small cup open at the side for the entrance of the cathodic rays, while the X rays escape through its mouth. In this way these latter, making their exit from a nearly closed cage, disappear completely discharged, and no longer carry off the platinum dust that rapidly blackens the Crookes tubes and necessitates the opening of the latter in order to clean them.

The Fluorescent Screen.—It has been known for over two years that fluorescent screens become exhausted when they are actuated by the X rays. Mr. MacIntyre has shown this by exposing to an intense pencil of rays a screen upon which he had placed some small disks of lead. When these latter were removed, the parts that they had protected stood out clearly from the rest of the surface. This transformation of the sensitive substance is not solely visible under the action of the X rays, for it is shown, too, in ordinary light by a change in the color of the salt, which, in the case of platino-cyanide of barium, assumes a brown tint, very distinct from the greenish color of the substance in its natural state.

It might be asked if the modification that the salt undergoes is permanent, and if the screen is positively destined to be put out of service at the end of a certain length of time. The modification is, at all events, of long duration when the screen is kept in darkness, since, after several days, we find in it the scarcely weakened trace of the preceding impressions. But screens also may be regenerated. To this effect, it suffices to expose them to a bright light, when all their sensitiveness will soon be restored to them.

Care must therefore be taken not to put the screens

used for fluoroscopy permanently at the bottom of their wooden cone, but, on the contrary, as M. Villard has well shown, to mount them upon a slide or upon hinges and expose them to the broad daylight during the entire time that they are not in service. This is a very simple method of preserving them forever in a perfect state.

For the above particulars and the illustrations we are indebted to La Nature.

DISCOVERY OF NEW CHEMICAL ELEMENTS.

By Clemens Winkler.

In his studies of the relative frequency of the different elements composing the crust of the earth, Mr. F. W. Clarke supposes that to a depth of ten miles below the level of the sea the composition of the ground is the same as is given by the examination of the surface strata and the depths which we have reached. The mean specific gravity of these strata is 2·5, or not quite half the density of the earth as a whole. Including the oceans and the atmosphere, the exterior crust of the earth is composed half of oxygen and one-fourth of silicon, while the other fourth is represented by other elements—aluminum, 7 per cent.; iron, 5·10; calcium, 3·50; magnesium, 2·50; sodium, 2·20; and potassium, 2·20 per cent. Some of the elements of which the numerous compounds have long been very obvious to the human ken are, therefore, from the point of view of their quantity, of very little importance; thus, hydrogen stands for only 0·94 per cent. of the general composition of the crust of the earth, carbonic acid for 0·21 per cent., phosphorus for 0·09 per cent., and nitrogen for 0·02 per cent. These elements, which are the constituents of immense seas and form the basis of life, therefore furnish only a minute fraction of the mass of the ten-mile-thick ring contemplated by Mr. Clarke. Since the soundings thus far made indicate that they do not exist or hardly exist at greater depths, we have a right to say that so far as regards quantity they may almost be neglected, in considering the mass of the whole globe. The content in chlorine does not exceed 0·15 per cent., yet the common salt alone held in the oceans is sufficient to cover all the continents and bury the highest mountains.

We perceive from this showing how little the impression the outer surface of our globe gives us corresponds with its real nature as we judge of it from its mean density. There cannot be the least doubt that the internal parts of the globe are composed of different substances from those which appear in the external strata.

But, while the elements of light specific weight or great volatility, which, like hydrogen and nitrogen, exist in large quantities around us, constitute only a very minute part of the constituents of our globe considered as a whole, we presume that the elements called rare only enter in an infinitesimal degree into the general composition of the earth; the more so, because, so far as we as yet know, these elements are not found at great depths. I, at least, do not know that the heavier metals—gold, silver, lead, etc.—have ever been found in the materials extracted from deep soundings or volcanic ejections. After the mighty eruption of Krakatoa, for example, I sought in vain for these elements in the cinders cast out, which probably came from great depths. The supposed discovery of a new element in the ancient lavas of Vesuvius has been found to be erroneous.

Elementary bodies seem to multiply as we approach the surface of the globe. Two hypotheses suggest themselves in explanation of the fact: that of displacements of cosmical matter and that of the new formation of elements on the surface.

The displacements of cosmic materials are incessant; falls of meteorites furnish a particularly striking example of them, but it is probable that as to quantity the cosmical dusts are of more importance. Yet neither the meteorites found at various points nor the dust collected by Nordenskiold in the ice fields of the polar regions, the extra-terrestrial origin of which cannot be doubted, contain the rare elements of the earth. The hypothesis of an increase by accretions from without appears to lack foundation.

The new formation of elementary bodies seems to be still less probable; at most it might be explained by the possibility, often indicated but never established, of a new reduction of bodies heretofore supposed to be simple. Spectrum analysis, it is true, reveals to us transformations which are gradually going on in the matter of the fixed stars, but they are only of known substances becoming converted into other substances equally known. Moreover, the conditions of temperature and aggregation of the fixed stars and those of the earth cannot be compared.

It is evident that the increase of simple bodies in the outer strata of the earth is only apparent. It should be recognized, besides, that science has made greater progress, and this progress cannot be without influence on the discovery of new substances. The first electrolytic decompositions accomplished by Davy with an inferior voltaic pile made known at the beginning of this century the existence of metallic radicals in the salts and the earth of which there had not been before the slightest suspicion; while Moissan, by the employment of the powerful currents now available, has been able to disengage fluorine—hitherto almost unknown—from its combinations. Spectrum analysis has cast light on a whole series of elements of characteristic spectra. The presence of one of these elements, helium, had been demonstrated in the sun before it was known that it likewise entered into the composition of our globe. The conclusions drawn by D. Mendeleef from the periodical law have also led to the discovery of several elements, the existence of which was indicated by theory before the chemist had isolated them. I mention, first, scandium, discovered in 1879 by Nilson in exonite, gadolinite, and yttrotitanite. This metal, the oxide of which exists only in quantities of a few grammes, and which no person, perhaps, other than the author of the discovery has had in his hands, possesses considerable scientific importance, because its atomic weight of 44, as determined by Nilson, is precisely that indicated by Mendeleef for ekabor, an element the existence of which was predicated by the periodic law.

In 1794, Gadolin had separated from the gadolinite of Ytterby an earth which he called the earth of Ytter, and which was afterward known under the forms of erbia, terbia, and yttria proper. These earths were found in a considerable number of rare minerals, but the oxides extracted from these minerals exhibited different natures and aspects, presenting themselves rather like mixtures in which the separation of the different constituents was attended by considerable difficulties, for the different elements gave no very distinct reaction. It was necessary to recur to spectrum analysis and to the determination of atomic weights, and to try to isolate them by repeated fractionings, under the action of sulphate of potassium or of ammonia, or else by the partial decomposition of the nitrates by heat. The bulk of these analyses, the results of which are not, however, entirely clear as yet on some points, have been performed within the last quarter of a century, and, besides securing more precise knowledge of scandium and yttrium, have revealed the existence of numerous other rare elements, the reduction of which does not seem impossible; among which we cite erbium, holmium, thulium, dysprosium, terbium, gadolinium, samarium, decipium, and ytterbium.

Cerium, lanthanum, and didymium have been the object recently of very attentive researches having a practical end in view—the constitution of mantles for incandescent gaslights. Didymium has been long suspected of not being a simple substance; but Carl Auer von Welsbach, the inventor of this method of illumination, is entitled to the credit of having succeeded, in 1855, in separating didymium into its two elements of præsodidymium and neodidymium. The utilization of monazite afterward permitted the preparation of the salts of these remarkable metals in larger quantities, and the practical use of them.

The existence of metacerium, announced by M. Brauner, does not yet appear to be fully established, nor that of russium, which M. Crushchow has found associated with thorium in some zircons and in monazite, and the atomic weight of which is calculated at 220. The jargonium of Sorby, the austrium of Linneman, the norvegium of Dahll, the actinium of Phipson, the idumium of Websky, the masrium of Richmond and Off, and an unknown element which M. K. J. Bayer thought he had found in French bauxite, have returned to nothingness. We mention also merely as a matter of curiosity a kosmium and a neokosmium, deriving their names not from Cosmos, but from Kosmann, who took out a patent for the preparation of their oxides.

Gallium was discovered in August, 1875, by Lecoq de Boisbaudran in the blende of Pierrefitte, through two very distinct lines in the violet of the spectrum of that mineral, which, however, as afterward appeared, contained only a slight proportion of the new metal—not exceeding 0·0001 per cent.—while in the richer blende of Bernbryer it amounted to 0·001 per cent. The preparation of gallium in any considerable quantities was attended with great difficulties on account of the want of a proper mineral to be practicably submitted to the extraction process, and none has as yet been found. Still, the study of the new metal was very interesting, in view of the theoretical speculations of Mendeleef. Scandium and germanium had not yet been discovered, and there was therefore nothing to justify or confirm the conclusions drawn from the law of periodicity. As early as 1869, Mendeleef had affirmed the existence of simple bodies still unknown, the atomic weights of which should be comprehended between 65 and 75; he had even gone so far as to describe in detail the properties of the three hypothetical elements—ekaboron, eka-aluminum, and ekasilicon. We can imagine the interest attached to the question whether the properties of gallium corresponded with the anticipations of the Russian chemist.

At first the correspondence did not seem to exist; the determinations made on the small quantities of gallium that could be obtained gave the specific gravity the unexpected value of 4·7. But as many of the properties of the new metal—such as the precipitation of its solutions by carbonate of barium, its tendency to form basic salts, and its capacity of forming alums—denoted a relationship with aluminum, Mendeleef had no hesitation in declaring that the new element appeared to correspond with the one the existence of which he had indicated in 1874 as similar to aluminum, and which he had called eka-aluminum. A new determination, made with considerable quantities of gallium obtained by electrolysis, brought the value of the specific gravity up to 59, which corresponds exactly with the value calculated by Mendeleef for the hypothetical eka-aluminum. The specific heat (0·08) was afterward found to correspond with Mendeleef's estimate, and the justness of his previsions was established. It was, therefore, shown to be reasonable to deduce from the properties of known elements those of others still unknown, but the existence of which is anticipated. Mendeleef had not expected so quick a confirmation of his previsions; but his triumph was destined to be still more complete, for to gallium were afterward added scandium (ekaboron), discovered by M. L. F. Nilson in 1875, and germanium (ekasilicon), discovered by me in 1886.

The discovery of germanium, predicted under the name of ekasilicon by Mendeleef, bears a resemblance to the discovery of the planet Neptune, the existence of which had been shown by the calculations of Adams and Leverrier. That discovery was not due to a concurrence of favorable circumstances or to a happy accident, but was the result of researches inspired by theoretic previsions, and the concordance between the predicted and the real properties was so great that Mendeleef regarded the discovery of germanium as an important verification of the periodic law. On only one point—that touching its formations in nature—did germanium completely fail expectations. The search for it would be more likely made as an oxide in the rare minerals of the north, along with titanium and zirconium, than as a sulphide accompanying similar compounds of arsenic and antimony in gangues of silver bearing minerals. This fact, with the comparative rarity of its mineral, argyrodite, has contributed no little to delaying the elucidation of its real character. For myself, I was at first inclined to regard it as eka-antimony, while Mendeleef, after my first incomplete communications, thought it was ekacadmium. At the same time, M. Von Richter expressed the conviction that germanium was nothing else than the long expected ekasilicon, a conclusion that was justified by the correspondence of atomic weights.

The success of the bold speculations of Mendeleef permits the affirmation that the elaboration of the periodic system constitutes a great forward step for science. In the course of only fifteen years all the predictions of the Russian chemist have been confirmed. New elements have come to fill the vacant spaces in his table, and there is every reason to hope that a like fulfillment awaits the rest of the natural system.

Yet the two elements last discovered, argon and helium, do not seem to present any relation with the periodic system. The physical properties of argon are very distinct; its characteristic spectrum distinguishes it with great certainty from all other substances; but chemically the gas manifests an extraordinary indifference, and it has not so far been possible to make it enter into the usual compounds with other elements. This peculiarity, and the impossibility of introducing a simple body of the molecular weight of argon (39·88) into the periodic system, have given occasion to all sorts of hypotheses concerning the gas; and the question of its relations has not yet been answered.

Another most interesting discovery is that of helium, which was made by Prof. Ramsay, in 1895, while examining the mineral cleveite for argon, when, besides the spectrum of argon, he observed another bright line not belonging to that spectrum, which Mr. Crookes recognized as identical with the line D^3 which Prof. Lockyer had observed in 1868 in the spectrum of the solar chromosphere, and which he attributed to an element not yet known on the earth—helium. The same line was afterward found in the spectra of other fixed stars, and the conclusion was drawn that helium exists in large quantities outside of the earth. On our planet it seems, however, to be very rare, and may even be ranked among the rarest elements. Yet it has been almost discovered several times. Palmieri observed the line of helium in his researches on the lava of Vesuvius, but did not push the matter further; and Hillebrand in 1891 obtained, in the spectrum of the gas formed by uranite, lines which were presumptively those of helium.

Since its discovery, helium has been found in a considerable number of minerals, generally associated with uranium, yttrium, and thorium; in mineral waters and in extremely small quantities in atmospheric air. Next to hydrogen, it is the lightest of the gases, and from this peculiarity Stoney draws an explanation of the fact that these two elements exist only in very small quantities in a free state on the earth, while they are diffused in enormous masses through the universe. The relatively small force of the earth's gravitation does not furnish an adequate counterpoise to the velocity of their molecules, and they escape from the atmosphere of the earth, unless they are restrained by chemical combination. They then collect around the great centers of attraction constituted by the stars, in the atmosphere of which they exist in large quantities.

The study of the spectrum of helium is extremely important, because it gives interesting data concerning the nature of distant celestial bodies. It also, as the labors of Runge and Paschen have shown, suggests doubts concerning the elementary character of the new substance. Whatever it may be, if we have to suppose that helium is composed of two gases (Mr. Lockyer has proposed the name of asterium for the second), one of the two gases probably has a boiling point very near the absolute zero, and in any case below -264° C.; for the master in liquefaction of gases, M. K. Olszewsky, has not up to this time succeeded in provoking a change of state of helium, and he proposes to use this gas for filling gas thermometers for measuring extremely low temperatures. Helium has shown itself thus far as refractory as argon to all chemical combination, and so great an uncertainty reigns over the position to be attributed to it that I pass by the hypotheses that have been set forth with respect to the matter.

It is not impossible that the discovery of these two new elements, argon and helium, may give occasion for a remodeling or a transformation of the periodical system—a remodeling by means of which some uncertainties and even contradictions now existing will undoubtedly be removed. Thus, for example, the atomic weight of tellurium, as recently determined by B. Brauner and Ludwig Standenmaier, does not enter at all into the periodical system; on the other hand, the existence in this substance of a foreign element, such as the austriacum suggested by B. Brauner, does not seem to be established. As to the much agitated question whether and to what extent the atomic weight of nickel differs from that of cobalt, I believe I have given a satisfactory answer, and have refuted the hypotheses of Gerhard Krüss and F. W. Schmid of the existence in one of the substances of a third element which has been called gnomium.

The rapid glance which we have cast over the discovery of new elements during the last twenty-five years shows that researches have been pursued in this direction with great activity, and with the return of considerable results. Yet the speculations for which these researches have given occasion with respect to the possibility of an ultimate decomposition of apparently simple bodies, and reciprocally respecting the progressive development of the primitive substance and the formation of many of the present elements, may be considered very uncertain. I mention among these Mr. Lockyer's hypothesis of the dissociation of the elements within the solar atmosphere. Hypotheses of this kind must remain hypotheses so long as we do not succeed in splitting a substance unequivocally regarded as simple, or in transforming some element into another; yet they need not be considered wholly inadmissible. Something unexpected may happen at any time that will open to science new roads of investigation. — Translated for The Popular Science Monthly from the Revue Scientifique.

The Boston and Albany road has sprayed 114 miles of its roadbed with oil this season, or from Boston to a point 15 miles beyond Springfield. It is intended to carry the work as far as Chester, or 126 miles from Boston, before the work is postponed. Eighty-two tanks of 6,000 gallons each were used. It is estimated that only one-third that amount will be required to sprinkle the same ground next year.

ENGINEERING NOTES.

The improvement in train service in England is shown by the fact that in 1884 there were but seven trains making runs of 100 miles or more without intermediate stops. In 1896 it had grown to 58, and the present year it has reached 78. A complete list of these trains with their speeds was recently published in Engineering.

A good deal can happen in two minutes. This brief space of time made all the difference between the "St. Paul" coming safely into New York Harbor and spending ten days on the sands off Long Branch. To stop the "Etruria," whose displacement is 9 680 tons, horse power 14,321, and speed 20·18 knots an hour, two minutes and forty-seven seconds are required, and during the process of stopping the ship will forge ahead 2,464 feet, or nearly half a mile. The United States cruiser "Columbia," with a displacement of 7,350 tons, 17,991 horse power, and a speed of 22·8 knots an hour, can be stopped in two minutes and fifteen seconds, and within a space of 2,147 feet. In each case the vessel is supposed to be going at full speed and the stoppage produced by reversing the action of the propeller.

The largest single contract ever let for an open hearth steel furnace plant was closed on September 24 between the Riter-Conley Company, of Pittsburg, Pa., and the Alabama Steel and Shipbuilding Company, Ensley, Ala. The contract calls for ten 50-ton "Wellman" rolling furnaces, the general dimensions being approximately 21 feet wide, 37 feet 6 inches long, with a total height above foundations of about 22 feet. The contract embraces everything complete above foundations, including steel castings, hydraulic cylinders, and all plate and structural work for casings, binding, pedestals, etc. The work requires approximately 400 tons of steel castings alone, while the total tonnage of steel work and all is nearly 2,000. The work is to be erected complete at the new steel works at Ensley, the foundations being already finished. A gas producer house and a storage bin, 18 feet wide by 343 feet long, both of steel construction, are also included in the contract.

It is not always possible to prevent steam boilers scaling, but when it occurs it is said to be easily removable by a method devised by M. Savreux, a French engineer. The following is his prescription: Rake out the fire, and let out the water only in small quantities, replacing such quantity by cold water, so as to keep the boiler filled. When quite cold, let all the water suddenly out. A great deal of the deposit will come away with it, and the remainder can be readily removed by scraping and brushing. But the cleaners have to be quick about it, for the deposit soon hardens and again sticks to the iron. At a works in Amiens the fire was let out on Saturday night; during two hours on Sunday the boiler was filled with cold water; Wednesday the boiler was polished; Thursday the water was again changed, and the same on Saturday. Sunday the water was let out, and the boiler promptly cleaned. This method is, of course, only applicable where there is a reserve boiler.

A mechanical achievement of some importance is being accomplished at Adelaide, West Australia, viz., the making of about nine miles of steel pipe, from 15 inches to 26 inches in diameter, after a new design of rivetless, longitudinal joint. Each section is 26 feet long, with but four pieces—two locking bars and two plates. Each plate is cut with square ends after passing through a train of leveling rollers, following which a planer with four cutters on a sliding table cuts the two longitudinal edges parallel, and sixteen rollers, eight on each side, carried by the bending rolls, upset the edges in a dovetail of uniform width and depth. Thence the plate goes through a hydraulic press, which upturns the edges, after which it passes through rolls that bend it into a half circle, two of these being placed in grooves, in locking bars, and temporarily clamped together. The pipe is next subjected to hydraulic pressure of 50 tons per inch on an expanding mandrel, the grooves closed, and the usual asphalt coating applied. The pipe is jointed in the trenches with steel rings and lead.

Segmental wire guns, to the number of 50, and costing $500,000, have been ordered by the War Department from the Brown Segmental Gun Company, of Reading, Pa. They include twenty-five 5-inch and twenty-five 6-inch guns. The Army and Navy Journal says that army ordnance officers protested against the contract on the ground that "there never had been a successful test of this gun." The Brown Segmental Gun Company answers this charge by saying that a 5-inch segmental tube wire gun, 44 calibers long, was some years ago turned over to Gen. Flagler for test. Though the contract called for a maximum chamber pressure of 50,000 pounds per square inch, 192 rounds were fired from this gun, with 43 rounds at pressures from 50,000 to 60,000 pounds, and 6 rounds with pressures ranging from 60,000 to 82,850 pounds per square inch. The gun survived this severe treatment, though the lining tube finally yielded; and this tube was only considered good for 150 rounds at 50,000 pounds pressure, instead of 192 shots. The company considers this a very successful and thorough test of the qualities of the wire-wound gun.

Prof. Ihlseng, of the State College, Pennsylvania, gives an interesting explanation of the difference between anthracite and bituminous coal, so far as the gases are concerned, his opinion being based on the supposition of all coal beds having been originally formed on a horizontal or flat bed. The anthracite beds, he assumes, were placed under enormous pressure, or side pressure, by the contraction of the earth's crust during the cooling stage, thus forming the coal basins as now seen at the foot of the mountains; such an enormous pressure resulted in forcing the explosive and other gases out of the anthracite beds to the seams and crevices of the veins and to the fissures, seams, and pores of the rock strata. This compression has been so great that gases in the anthracite region are sometimes found with the mighty pressure of 17,000 pounds to the square inch. On the other hand, the bituminous beds have not been subjected to such a disturbance and pressure, and the coal, therefore, retains the gases which it contained originally. White damp, Prof. Ihlseng shows, is produced by imperfect combustion, while black damp is produced by perfect combustion, and destroys life by being devoid of sustaining elements.

MISCELLANEOUS NOTES.

A church is being erected in St. Louis for the St. Francis de Sales congregation which, according to the St. Louis Post-Dispatch, will have the highest steeple in this country. The top of the spire will be 378 feet from the ground. The tower structure will consist of stone walls 6 feet thick at the bottom, on a base 50 feet square, and it will cost $225,000.

The official report of the mineral resources of the United States issued by the United States Geological Survey gives the production of copper for 1897 as 491,638,000 pounds, which is valued at $54,080,180, this being an increase of about 7½ per cent. over the previous year. Of aluminum the production is given as 4,000,000 pounds against 1,300,000 pounds for the previous year, the value for 1897 being estimated at $1,500,000.

The 250 foot tower erected in 1893 on top of the Tower Hotel at Sixty-fifth Street and Stony Island Avenue, Chicago, within a stone's throw of Jackson Park, is now being taken down. As a financial venture the tower was a failure, and the elevator in it ran only a few days after it was opened to the public. Since the Fair, however, it has remained as one of the most conspicuous landmarks. All that now remains of the "White City" is the art gallery and the German building.

In order to avoid over-production in acetylene generators, in which the pressure of gas lowers the water from the carbide, from moisture remaining after production should be stopped, it has been proposed in a communication to the French Society to steep the calcium carbide in hot concentrated solution of glucose, says The Electrical World. In the subsequent production of acetylene a sucrate of lime is formed by the action of the glucose, the calcium and the oxygen, which stops the generation almost immediately on the cessation of the water supply.

Austria-Hungary is making an interesting experiment to open up new channels for its trade. A steamer, the "Poseidon," fitted up as a floating exhibition of the products of the monarchy, will soon leave Trieste for the chief ports of the Levant, the Red Sea, Hindostan, the East Indies, China, and Japan. Its arrival will be extensively advertised beforehand at each port, and commercial travelers on board will try to secure orders for the exhibitors and to find capable agents at the points touched. The government has granted a subsidy of 50,000 florins to assist the enterprise.

It appears from recent consular reports that American-made goods, such as cut glass, cotton, bicycles, and other articles, are gaining in favor in Europe. For instance, it is stated in these reports that American silk is being sold in Lyons, the real silk center of France, and that French manufacturers are buying it in large quantities, especially silk of the grades used for lining purposes, to take the place of that formerly imported from Austria and Germany. The demand for American pearl goods and cut glass is increasing because of superiority in quality. Canned goods and bicycles also share in the popularity. From the Ghent consular district a report on the commerce for 1896 says the cotton mills are employing more and more American cotton. The demand for the raw material is annually increasing by reason of the larger number of spindles set in motion. The importation of American hardware on the market shows considerable increase. The introduction of American bicycles was also marked during 1896, and with present quotations United States manufacturers will strongly compete with their foreign rivals.

Before a meeting of the Royal Society of Edinburgh, held recently, Mr. T. C. Baillie read a paper on the thermal conductivity of nickel. The value he obtained by use of Forbes' method was 0·117. What was believed to be a better value—namely, 0·103, was obtained by a new method, which had the great merit of giving an experimental value of the thermal conductivity directly, without requiring the specific heat to be known. A short bar had its one end kept at a steady high temperature as in the Forbes experiment. To the other end a small cap was attached, through which a steady stream of water was passed. The temperature of the water was taken just as it entered the cap and just as it left it. The quantity of water passed in a given time being known, the amount of heat lost from the end of the bar to the water was calculated in terms of the specific heat of water. By means of thermometers set at intervals along the bar, the gradient of temperature was indicated, and a good approximation to the value of the gradient at the position occupied by the cap could be calculated. These measured quantities, the gradient and the heat lost, give at once the conductivity.

Some new and important regulations of the trade in artificial mineral waters in Hungary are reported by Consul Chester of Budapest. According to these, licenses to manufacture artificial mineral waters may be issued only to druggists or chemists holding diplomas. The erection of factories for such manufacture will be permitted only after expert examination. The local authorities are expected to care for the regular medical supervision of such factories. The names of domestic or foreign natural mineral waters may not be made use of. It is also forbidden to use the same bottles, jars, capsules, corks, stamps, or trade marks for artificial mineral waters as for natural mineral waters of similar composition, and the word "artificial" must be marked in large letters on all vessels containing artificial mineral water. In connection with this ordinance of the Hungarian minister it may be pointed out that mineral waters form one of the principal articles of export to the United States from Budapest and the surrounding locality. Under the United States tariff law of 1894, says the consul, owners of mineral springs in foreign countries were obliged to certify that the water exported by them to the United States was in no way prepared by manufacture. As such certificate was required at the production of each invoice of water, the people of the United States were in some degree protected against artificial imitations of the genuine Hungarian bitter waters. Under the United States tariff law of 1897, however, natural and artificial waters are admitted under like conditions of payment of duty, and a certificate of origin has been dispensed with.

SELECTED FORMULÆ.

Waterproof Gelatine Paper.—In waterproof gelatine paper the paper is coated on both sides with a solution consisting of—

Gelatine	1 part.
Water	4 "
Glycerine	1 "

Coagulate the gelatine and immerse the paper in a solution of 750 c. cm. of formol in 5 liters of water. The paper thus treated is, after drying, impervious even to steam.

Photography in Hot Weather.—The photographer meets with various difficulties at all times, but perhaps more troubles crop up in the summer than at any other season of the year. One of the difficulties of the photographer in the hot weather is to produce a perfect negative. When I say perfect, I mean one that is entirely free from any signs of fog or frilling. The dark room is often small—too small, in fact, for the quantity of work that has to be done in it. In the hot weather, even if well ventilated, it often becomes stuffy and close. The consequence is that the temperature of developers and other solutions comparatively small in bulk gets rather high. Now to develop a plate with a solution of a temperature much above 60° F. is almost sure to produce a frilled and chemically fogged negative. A plan which I have found very effective in reducing the temperature of the dark room is to place in it a bucket or other large vessel filled with cold water. The water partly absorbs the heat, and makes the room far more comfortable to work in. The bottles containing developers and other solutions are placed in a large vessel containing cold water, which soon lowers the temperature of the various solutions. The fixing bath should be made up fresh every day. This insures getting a cold solution. It should not be used any stronger than 1 in 4—a stronger solution tends to produce frilling. Extra bromide should be used in the developer; two or three drops of a 10 per cent. solution to each ounce of developer, in addition to the quantity generally used, according to exposure.—Amateur Photographer.

Copying Inks, Black and Violet.—The following, if good materials are used, and care is taken in the manipulations, will give an excellent black copying ink: Into a clean jar put 425 parts of Aleppo galls, coarsely powdered, and pour over them 4,500 parts of water, and 56 parts of glycerin. Set aside to macerate for ten days, with frequent stirring up from the bottom. Dissolve 70 parts of gum arabic in sufficient water and add to the liquid. Dissolve 170 parts of crystalline iron sulphate, c. p., in sufficient hot water, and add the solution to the foregoing. Let the whole now stand fourteen days longer, with an occasional agitation, and then strain off. Add 150 parts of loaf sugar, and dissolve. Finally filter. This is the best black ink made, and is exclusively used in all the correspondence of the Bank of England. If the ink does not copy freely enough, add a little more sugar, or a trifle of glucose. A good violet copying ink has the following formula:

Extract of logwood	80 parts.
Oxalic acid	1 "
Alum, in fine powder	6 "
Glycerin	2 "
Potassium dichromate	1 "
Wood vinegar	10 "
Rain or distilled water	180 "

Mix the glycerin and water, and in 160 parts of the mixture dissolve the first three ingredients, and in the remaining fluid dissolve the dichromate. Let the solutions stand twenty-four hours, then mix them. After letting the mixture stand another day, put it into a copper kettle and bring to a boil. While boiling, add the wood vinegar, let the boiling continue for one minute, then remove from the fire and let cool down slowly. Let stand until all sediment is thrown down, then decant carefully and fill into bottles. This ink flows freely, and does not mould.—National Druggist.

Perfuming Pastils.—By the slow combustion of certain gums, woods, etc., a fragrant odor is diffused through the air, this result being due in large measure to the evaporation of some of the odorous principles unchanged. A convenient way, long practiced, to attain the end indicated, is to mix ground woods, etc., with potassium nitrate, bind into a mass with mucilage and form into little cones. These when dry burn slowly on being ignited, never breaking into flame, and the heat being thus minimized, volatilization of a portion of the odorous matters present with some products of decomposition is accomplished. The potassium nitrate furnishes the oxygen by which the combustion is sustained; the mass would not burn without a draught except for this aid. Piesse, in his Art of Perfumery, points out that during the slow combustion of the woody matters when used in pastils, products are formed which are unpleasant in odor, and to remedy this defect he proposed using charcoal as the base of the pastil, adding to it essential oils, and assisting combustion, as usual, by potassium nitrate. The carbon dioxide produced by the burning of the coal has no odor, and destructive changes involving the production of one would be limited to the oils. For the kind of pastil advocated by Piesse the following recipe is a type:

Willow charcoal	4 ounces.
Potassium nitrate	3 drachms.
Oil of thyme	15 minims.
Oil of caraway	15 "
Oil of rose	15 "
Oil of lavender	15 "
Oil of clove	15 "
Oil of sandal	15 "
Tragacanth mucilage, a sufficient quantity.	

Beat together into a stiff mass, which form into pastils. Pastils are commonly made of conical shape, about three-quarters to one inch long and three-eighths of an inch at the base. This base is made square and level, so that the pastil will easily stand upright. It is ignited, of course, at the small end, the flame, if any, blown out, and combustion then proceeds slowly. It is scarcely necessary to say that in use the pastil should be so placed as to avoid all risk from fire—a risk which may be overlooked sometimes on account of the inconspicuousness of the combustion. Great heat is generated, however, and the ignited mass should be placed in a candlestick or similar contrivance.—Druggists' Circular.

THE BEAVER.

Nowadays live beavers are seldom seen except in zoological gardens, in Germany, at least, they have become rare, but formerly they must have been very numerous, for in the old cook books we find receipts for making toothsome dishes of their flesh. Their fur is valuable and the castoreum—a secretion of the glands located close to the tail of the beaver, which has a bitter taste and a sharp, penetrating odor—has been much sought after as a remedy for hysteria and gout.

Being a rodent, the fore part of the beaver's body resembles that of the marmot and the rat, while the hind part is adapted to his life in the water. He belongs to the largest species of his family, being more than a yard long and weighing from 40 to 60 pounds. His fur, which is of a chestnut color, is prized because of its soft, woolly character, but the long, stout gray hairs are even more valuable; they make excellent paint brushes. The beaver has four large, chisel-like teeth, which serve him well in his work, building dams, etc., enabling him to strip the bark off trees and to cut through tree trunks and branches of considerable thickness. His fore feet are small and, like those of the squirrel, are used for grasping his food and other articles. His hind feet are comparatively large and webbed so as to be most useful in swimming, while his broad, flat tail, which is covered with scales, serves as a rudder.

But the animal himself is not as remarkable as his manner of living and the structures he builds in the water, from which men might learn many lessons. Beavers are sociable animals; several pairs of them live together in the long passages which they, like other rodents, burrow in the ground. These passages always communicate with the water near which they lie, and in order to keep the level of the water as constant as possible the animals build dams, using for this purpose the parts of trees which they have cut into lengths of a yard or more, and which are dragged into the water at a favorable location, where they are laid horizontally and covered with earth and stones. These dams are carried as high as is made necessary by the depth of the water and are sometimes hundreds of feet long. The streams themselves aid in making the dams solid by depositing against them the wood and stones carried down by the current. In the reservoirs above the dams the beavers build their "lodges," round structures which are put together in a manner exactly similar to that employed in the construction of the dams. The "lodges" are used by the animals less as habitations than as places of refuge when the water rises very high. The work of the beavers often changes the character of the landscape entirely, making a series of ponds where before there was only a brook or river, while along the banks the woods have been cut away, leaving the so-called beaver meadows, sometimes the only clearings in the virgin forest.

The peaceful times in which the beaver could carry on his work unmolested have passed away in almost every part of the world; only in North America is the fur hunter who wanders about in search of their habitat well repaid for his trouble.—Illustrirte Zeitung.

THE EXCAVATIONS AT CORINTH.*

By Rufus B. Richardson, Ph.D., Director of the American School at Athens.

It was with considerable impatience that I waited for the opening of this year's excavation campaign at Corinth. Two years ago our pioneer attempt had been very successful, in that our twenty-one trial trenches, besides yielding several objects of interest, located and partly uncovered the theater, and showed that an important center of the city's life lay in the valley east of the temple. Last year we had made a beginning here with the hope of finding the agora, from which we could, by following the description of Pausanias, lay out the topography of Corinth with great ease and certainty.

This search was more interesting than the process of uncovering a badly ruined theater; and since our work was interrupted last year at the end of one week by the war, we began this year at the same spot, March 23, carrying off the earth to a little distance with a track and twelve cars. The earth had to be carried to the cars in baskets, and the work was much slower than I had anticipated. I had, however, chosen the valley partly because the earth lay so deep there and inspired hope that the Roman occupation had not obliterated all traces of the Greek city, and I had no right to be discouraged. But as day after day passed with almost no results, except the broadening and deepening of the great hole, I thought of those who had contributed money to the cause in hope of conspicuous results; and my anxiety for such results became oppressive.

Only after a month did the realization of our hopes come. What has most impressed the people here and has done more than anything else to make our work a nine days' wonder and a thing to be visited even by women, is a big Roman statue without a head. If one does not find statues, the local population pronounces an excavation a failure. But we value our walls of careful Hellenic workmanship, with Greek letters on the blocks, more than a dozen headless Roman statues. Our inscription of the seventh century B. C. is our delight, and the stone on which is inscribed "Synagog of the Hebrews" is of great interest. If we must needs have sculpture to make success, we have several little reliefs and a torso of a figure the exact counterpart of the "Acropolis Maidens," only smaller. In these we find more interest than in our big Roman. Our best find is a large amphora of geometric style with a skyphos of the same style used as a cover.

But we have even come to a larger hope. The object of our search, the fixing of the agora, seems about to be realized. By descending a well in the immediate vicinity of our excavation terrain, we come upon rock cut channels in several branches leading down from Acro-Corinth, and explored about three hundred meters of them, wading in water. About thirty feet back from the edge of our excavations the main channel had in front of it, where the natural rock covering it comes to an end, a series of six chambers, with their ceilings partly formed by the rock stratum and partly by added limestone covered with hard, white stucco. The very moment that I saw them I said, "This is the Pirene of Pausanias." This writer, in speaking of the water supply of Corinth, says that it has many fountains in various parts of the city; but only of Pirene does he say that it is "equipped with chambers like caves, from which the water flows out into a fountain." He appears to regard the chambers as made of marble, it is true; but they may well have looked like marble to him; and there is also a possibility that we may find marble fronts of them; for so far we have entered these chambers only from their back sides.

There is little doubt that we have discovered, but not yet uncovered, the famous fountain of Corinth, which, appearing in the lower town, received the same name as its source in Acro-Corinth, and supplied the stately city of Periander as it now supplies the wretched hamlet which to-day passes under the name of Old Corinth. We are now bending our energies to the laying bare of the façade of this fountain, not to the exclusion of other work; and though we have over twenty feet depth of earth to deal with, we hope to accomplish it before the first of June. If not, and if the money holds out, we shall fight it out if it takes all summer.

The result already gained, but not yet shown to the world, is of great importance, all the greater because a result gained here is seven times magnified because it is at Corinth. The narrative of Pausanias puts Pirene at a slight distance below the agora on the road to Lechæon, the harbor on the Corinthian Gulf. We have dug two more trial trenches about two hundred yards further up toward Acro-Corinth, and in both we have found a long Greek wall, proving for it an extent of over a hundred and fifty feet. In one of the trenches there appear to the south of this rather narrow wall two massive walls, a delight to behold, parallel to this wall and to each other. If these two walls appear also in the second trench at a point which we shall reach tomorrow, it is nearly certain that we have some long porch which must be the border of the agora. The series would be too long for any other sort of building. The moment is exciting. Even the one wall, without the other two, points, by its great length, not yet fully ascertained, in the same direction.

But without counting conclusions to be derived from these walls, if we have Pirene, we shall have to place the agora almost exactly at that place.

A result of considerable interest is that we can now,

* The Independent.

BEAVERS AT WORK.

as I have long hoped to do, give a name to the venerable temple ruin which has long stood as the only handwork of Periander's Corinth. It must be the temple of Apollo mentioned by Pausanias as the first object of interest on the right of one going from the agora on the road toward Sikyon.

Not wishing to be without advice in such an important matter, I asked Dr. Dörpfeld to visit us. After climbing down the well and crawling along the channels and looking at the chambers, he came up, and, with Pausanias in his hand, said: "I believe this is Pirene. Uncover this and show it to the world, and it will make an impression. There will be no further question about the result of your work. You have success enough for one season."

This verdict has especial weight when one knows that it involves a recasting of Prof. Dörpfeld's topography of Corinth. He had hitherto placed Pirene a third of a mile further north, putting the agora north of the square of the modern village, and the Apollo temple near the edge of the lower terrace far to the north of the old temple ruin, which now seems about to come to its rights and take that name.

In my days of discouragement I had read in a Greek newspaper that the Austrians, who were excavating the temple of Artemis at Lusoi in Arcadia, had achieved a brilliant success, finding statues, bronzes, bronze plaques with inscriptions, etc. Although we all rejoice in one another's success, and although the Austrian directors were my dear friends, I could not help thinking, "Why cannot we also have something? Why didn't I get a site with less depth of earth?" But on going up to Athens the day after Prof. Dörpfeld's visit, I experienced quite a pleasing sensation in being congratulated right and left on the grand success of our enterprise. One of the first comers was Dr. Wilhelm, of the Austrian School, who expressed his joy, and regretted, and I with him, that his own work at Lusoi had been fruitless.

Athens, Greece.

THE MILON TRIO, MODERN ATHLETES.

ALTHOUGH our age can hardly produce forms like those of the Apollo Belvedere, of Achilles, and of the Discobolus, celebrated in the mythology and classic art of the Greeks, there are nevertheless many men in numerous athletic clubs and on the so-called "variety" stage who are not far inferior in physical beauty to their Greek prototypes. Among the acrobats who are attracting much attention by reason of their marvelous exhibitions of strength, as well as by their grace, may be mentioned the Milon trio. The concluding feat of these performers is certainly as imposing as it is remarkable. Two of the Milons stand on pedestals placed at each side of the stage, and hold between their teeth a wire rope on which the third of their number stands and lifts hundred pound weights and dumbbells. These latter he holds at arm's length and raises in the air several times, balancing himself all the while on one leg, a feat which fully testifies to the immense strength of the two human pillars. Around the bodies of the two athletes, straps are passed and connected by means of an iron ring, with heavy chains secured to the pedestals. By this means the wire and its weight of 350 to 400 pounds is prevented from tearing the men from their places. Even with the assistance of these chains, the jaws, sinews, and muscles of the neck and back are subjected to an enormous strain and must consequently be abnormally developed.—Illustrirte Zeitung.

FOREIGNERS IN JAPAN.*

By R. VAN BERGEN, Formerly Principal of the Nobles' School, Tokyo.

FOREIGN residents of Japan look with apprehension forward to the 16th of July, 1899, as the time when the new treaties will go into effect, and the old safeguard to life and property, the ex-territorial clause of the present treaties, will be abrogated. There is a possibility, but it is very slight, that the date may be postponed. Germany, when it consented to a revision of the treaties upon the basis of judicial autonomy, stipulated that the codes shall be completed and shall have been in operation for one year before its subjects shall be placed under Japanese jurisdiction. That country, at any rate, protected its citizens against incomplete codes; but why we should not be safeguarded against an inexperienced and prejudiced judiciary is more than the foreign resident can understand.

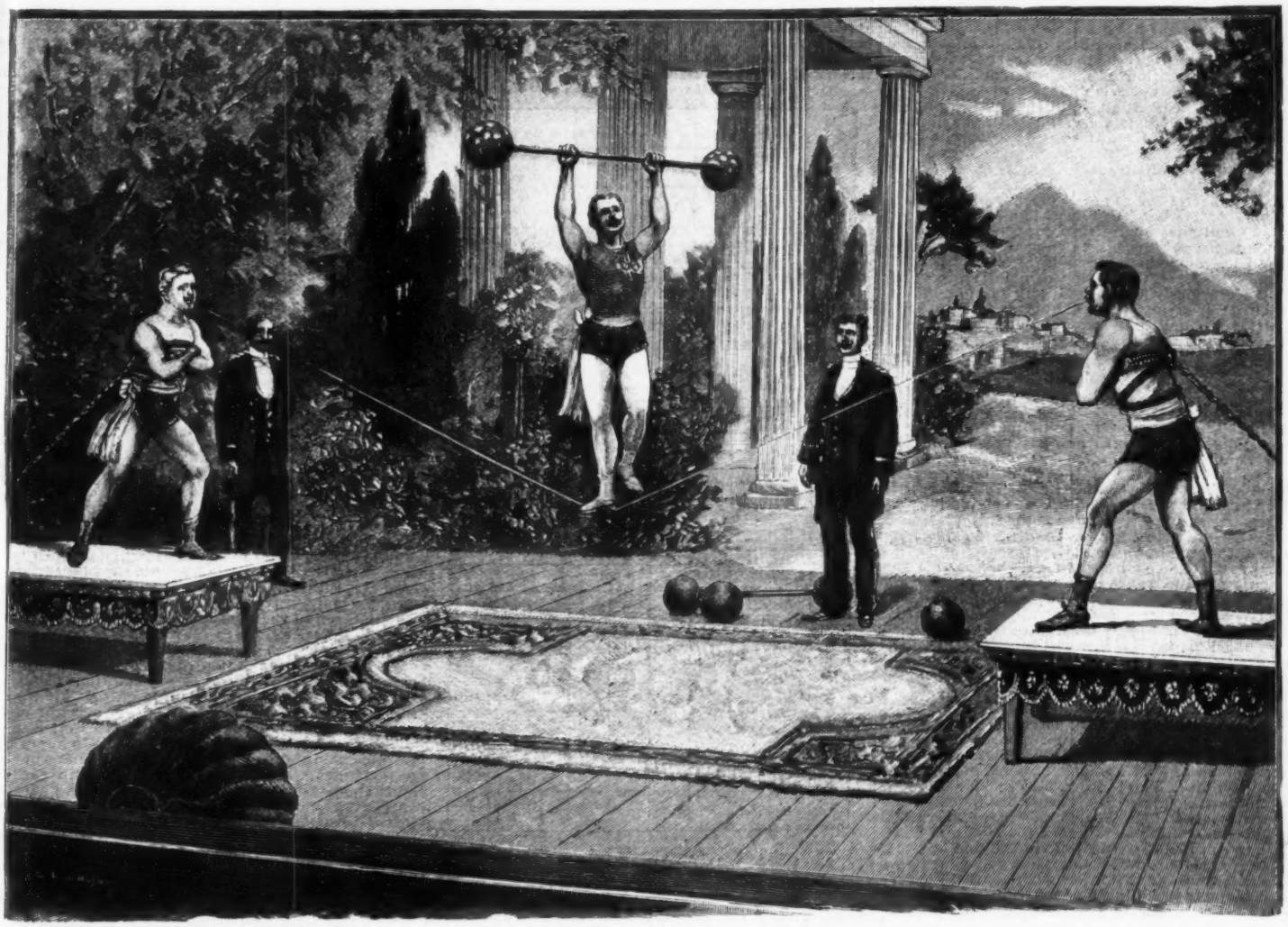
It is not, in these days, the acme of happiness to be a resident of Japan. In the recent treaties of the Mikado's empire with China and Corea the statesmen of Japan insisted upon the ex-territorial clause. They decline intrusting Japanese subjects to the tender mercies of irresponsible judges; and while in their inmost thoughts they marvel at the indifference of foreign powers, they evince a perceptible tendency to visit their contempt upon the unfortunate foreigners who are compelled to dwell in the Tenno's realm.

The fact is that the situation in Japan is entirely misunderstood. The public of the United States still look upon the Island Empire as a regenerated nation—one that has discarded the shackles of an obsolete civilization, and has entered into the comity of western nations with the well-defined purpose of emulating them. No opinion could be more erroneous. So far from being in love with us and our institutions, they regard us with a cordial hatred, and look upon our social conditions with heartfelt contempt. It is quite true that they have adopted our public improvements; that railroads, telegraphs, the telephone, and the electric light have been introduced, and that the service of these important social factors is constantly being extended. Nor can the fact be gainsaid that every modern invention improving the condition of army and navy is anxiously watched, and adopted as soon as its value has been demonstrated. These facts granted, it is none the less true that the ill feeling against us is intense.

The government, in 1893, intrusted to the Department of Education in Tokyo the task of publishing a "History of the Empire of Japan," the first edition of which was speedily suppressed on account of the writers allowing their anti-foreign feeling to transpire in its pages. A new and purged edition was issued, but even in that work the national feeling occasionally crops out. In summing up the condition of Japan as it actually exists, the authors state: "During the early years of the Meiji era, any knowledge, however slight, of western sciences and arts was regarded as a qualification for official employment. Students who had shown themselves intelligent were sent to Europe or America to inspect and report upon the conditions existing there; and as each of these travelers found something new to indorse and import, the mania for occidental innovations received constant increments. To preserve or reserve old fashions was regarded with contempt, and so far did the fancy run that some gravely entertained the project of abolishing the Japanese language and substituting English for it. By degrees, however, men's eyes began to be opened to the fact that, while they were uprooting and abandoning much which had the sanction of tradition and the approval of long practice, they were planting in its stead institutions and customs not necessarily suitable to the Japanese, and possibly injurious to any people. Out of this sense of rash denationalization and unpatriotic radicalism a strong reaction ultimately grew, and men's minds turned once more to the customs and canons handed down from their ancestors. The reaction is now paramount, but the introduction of western civilization is, at the same time, never neglected." *

To one who, like the writer, has seen Japan emerge from a distinct theocratic republic into the present hierarchic, so-called constitutional government, there is nothing to marvel at, provided he has analyzed the Japanese mind, so as to understand the impulses producing the natural effect. From time immemorial, Japan, divided into clans, has been governed by the Samurai or Shizoku, as they are now officially designated. Every clan was virtually a republic enjoying the greatest autonomy, the qualified voters being the Shizoku, the Daimio a mere figurehead. † It was the Samurai caste that caused the downfall of the Shogunate, and the impulse inducing the leaders to introduce occidental improvements was nothing else than the desire "to thrash the foreigners, in our turn."‡ When united Japan abolished the clans, the great question was what would become of the Samurai. Okubo and Kido were in favor of the abolition of class distinctions. The result was the frequent insurrections culminating in the Satsuma rebellion of 1877. The government remained victorious, but when, on May 14, 1878, Okubo was assassinated, the other members of the government were seized with a panic and surrendered at discretion. From that time dates the reaction to which the official historiographer somewhat proudly refers. Japan has discarded our furniture, sleeps on tatomi (mats), wrapped in a futon (comforter), warms itself in winter over the hibachi (charcoal brazier), eats its national food of rice, fish, and vegetables with the national chopsticks, and

* From the Outlook.



ONE OF THE MILON TRIO LIFTING A WEIGHT, WHILE STANDING ON A WIRE HELD BY TWO OF HIS COMPANIONS.

* "History of the Empire of Japan," published by order of the Department of Education, Tokyo, p. 409.

† "History of the Empire of Japan," from p. 334.

‡ T. Takayanagi in "Sunrise Stories." Scribner, 1896 (Conclusion).

dresses in kimono (gown), obi (sash), haori (mantle), and hakama (bifurcated petticoats), just as their fathers did when Perry first forced his unwelcome presence upon them. "Even now," says a well-known encomiast of things Japanese, "under a written constitution and a representative government it is the four hundred thousand adult male Samurai who rule the forty millions of people, make the politics, and shape the destinies of Tei-Koku Nippon."*

If this be thoroughly understood, the astounding anomalies or idiosyncrasies of Japan disappear. The Samurai class, consisting, as Mr. Griffis correctly states, of about four hundred thousand households, fondly and honestly believe that they are the lineal descendants of the Kami or gods who created the empire for their especial benefit, as their Tenno or Heaven-Child is the direct descendant of Amaterasu, the sun goddess. Their traditions point to an undisputed reign as far back into the dim ages as their records go. Any one not belonging to their illustrious caste is an inferior being, to be treated with a hauteur of which the non-resident has no conception. And woe to the man who assails this doctrine! "Even as late as the year 1892," says the above quoted author, "a learned professor in the Imperial University was punished for studying Japanese history with critical care, as Europeans study it, and saying that the Mikado's ancestors were Koreans."†

The offices, civil and military, are in the hands of the Samurai. They constitute the members of the lower house in the Diet, and thoroughly control the upper house. Every member of the Cabinet, without exception, is taken from their ranks. They control the press and occupy the benches of the judiciary. And when one of their members commits an outrage he is solemnly whitewashed, as was the case with Miura, whose instigation of the brutal murder of the late Queen of Korea was abundantly proved.

This explains the constant disputes between foreigners and Japanese, ending invariably with the discomfiture of the former. Even the missionaries, who carefully and rigorously abstain from so much as an expression on public affairs, suffer, as was the case, now notorious, in the matter of the Doshisha. The Japanese, since the return to power of the Shizoku, have been convinced that they are immeasurably our superiors; and they evince that supposed superiority in an arrogance and conceit which bodes ill for those who shall be compelled to remain after July 16, 1899. Many of us, however, will grasp the opportunity which they have graciously left us, and which is forcibly expressed in their saying, "We did not ask you to come here. If you don't like us, get out! No one will oppose your departure!"

A NEW GAS.‡

By Charles F. Brush.

The purpose of this purely preliminary paper is to announce the discovery of a new gas, presumably elementary, and possessed of some extraordinary properties. It is a constituent of the atmosphere, and is occluded by many substances. Its chief characteristic thus far ascertained is enormous heat conductivity at low pressures. In order to appreciate this phenomenon, it is necessary to consider the heat conductivity of some of the well known gases.

A year ago I had the honor to read before this section a paper on the transmission of heat by gases, and illustrated by numerous curve sheets showing the heat conductivity of several gases at all pressures from atmospheric down to the best vacuum obtainable; also an allied paper on the measurement of small gaseous pressures. Abstracts of these papers appear in the current volume of Transactions, and their full text may be found in The Philosophical Magazine for January, 1898, and November, 1897, respectively.

The apparatus used for the described experiments in heat transmission consisted, in part, of a long-stemmed thermometer hanging in a long-necked glass bulb; the bulb of the thermometer being in the center of the glass bulb. Two bulbs were used for different experiments; the larger one 112 mm. in diameter, the smaller one only 20 mm. A tank of water and crushed ice under the bulb was adapted to be raised when desired, so as to immerse the bulb in the cold mixture. The neck of the bulb was connected with an air-pump capable of reducing the internal pressure to a very small fraction of a millionth of atmospheric pressure; also with an elaborate pressure gage adapted to measure small pressures with very great precision, and a barometric gage for measuring larger pressures.

In using this apparatus, the gas to be tested was introduced at atmospheric pressure; the ice-tank was raised, and the falling temperature of the thermometer, which could lose heat only by radiation, conduction, and convection through the surrounding gas, was observed through a telescope. The time required for the temperature to fall through a given range, usually from 15° to 10° Centigrade, was carefully noted. Then the ice tank was lowered, permitting the thermometer to regain the temperature of the laboratory; some of the gas was pumped out, and the cooling of the thermometer again observed at this reduced pressure. This process was repeated many times, until the pressure was reduced to the lowest point attainable.

The results obtained with each gas were plotted in a curve showing its heat conductivity at all pressures from atmospheric down; the ordinates representing the reciprocals of the time of cooling in seconds, while the abscissas represented the pressure.

The present chart shows curves representing the heat conductivity of several gases, from fifty millionths of atmospheric pressure downward. The data for all of these, except the helium curve, are taken from last year's paper, but the scale is different.

I am indebted to Prof. Ramsay for the helium used in obtaining the curve here shown.

The ordinates of each curve measured from A B as a base line represent the total rate of heat transmission by the ether and the gas at the pressures indicated by the abscissas; while the ordinates measured from the line C D represent the heat transmitted by the gas alone.

It will be observed that the curves of all the gases named vanish together at the point of zero pressure, D. Repeated experiments have shown this condition to be always strictly true within the narrow limits of errors of observation, provided that before the introduction of the gas to be tested the whole apparatus has been kept highly exhausted for several days; or, better still, has been heated several hours by means of air and water baths, while kept exhausted. Without one of these precautions, I was never able to get any gas curve quite down to the point, D, for reasons which will appear. The point, D, represents a period of three hundred seconds required for the temperature of the thermometer to fall from 15° to 10°, with the pressure of the surrounding gas reduced to one twenty-millionth or less.

A very brief account of the circumstances which led to the discovery of the new gas may not be out of place. I had long been engaged in high vacua experiments, and had observed that glass apparatus when highly exhausted and heated, evolved gas for an indefinite length of time—rapidly at first, then slower, but never stopped until the temperature was reduced. On cooling, rapid reabsorption always took place, but was never complete, indicating that two or more gases had been evolved by heating, one of which was not absorbed on cooling. In other words, the absorption was selective. The truth of this conclusion was abundantly demonstrated subsequently. However, the percentage of reabsorbed gas was so large that I used a small quantity of pulverized glass in several experiments, to absorb a part of the residual gas after the highest attainable exhaustion was reached. The pulverized glass was always lead glass like that of the apparatus, and was heated nearly red hot for several hours before and during the final exhaustion.

During these experiments a curious phenomenon was noted; the pulverized glass lost its snowy white-

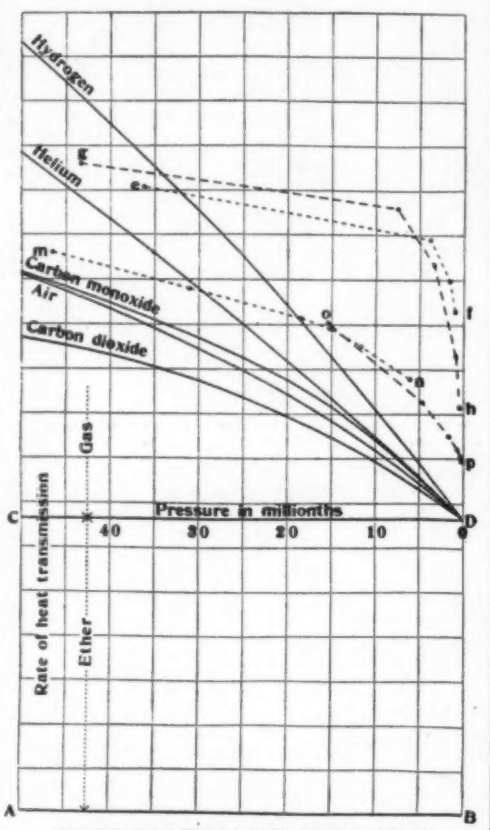


CHART SHOWING RELATIVE HEAT CONDUCTIVITY OF GASES.

ness. This I thought must be due to reduction of some of its lead; probably by hydrogen evolved on heating. If so, I argued that the hydrogen must have been absorbed from the atmosphere since the manufacture of the glass; and its presence in the glass, if proved, would be a long step toward proving the normal presence of hydrogen in the atmosphere.

Following the line of experiment thus suggested, I prepared a quantity of pulverized soda glass free from lead, and placed about 120 grammes of it in a large combustion tube connected with the apparatus already described. The glass was made from an old stock of tubing, and was of such a degree of fineness that it all passed through a sieve of 90 meshes to the linear inch, but would not pass through a 140 mesh sieve. The combustion tube was adapted to be heated by a gas furnace with automatically regulated gas supply, so as to be maintained at any desired temperature.

While prepared to make analysis in the usual way of the gas evolved by the pulverized glass in case it appeared in sufficient quantity, I relied chiefly on its heat conductivity for the detection of any large proportion of hydrogen in the last few millionths, not being prepared at that time for spectroscopic examination; and thinking that perhaps some hydrogen might be evolved in the last stages of exhaustion before heating, I tested the conductivity of the residual air from time to time as the preliminary exhaustion progressed.

When the exhaustion approached a good vacuum, an astounding phenomenon developed. At 36 millionths pressure the residual gas conducted heat twice as well as air, and nearly as well as hydrogen; at 3·8 millionths it conducted seven times as rapidly as hydrogen; at 1·6 millionths, fourteen times, and at 0·96 of one millionth, twenty times as rapidly. These results are plotted in the curve, *e f*. I did not carry the exhaustion lower than 0·96 M. At this pressure the time of cooling of the thermometer from 15° to 10° was only 177 seconds, while pure hydrogen would have required 288 seconds.

Evidently a new gas of enormous heat conducting capacity was present, mixed with the last small portion of air. It must have come from the pulverized glass, and probably formed only a small fraction of the mixture. The last c. c. of gas pumped out was collected, and upon subsequent analysis of it, nothing but air was found.

The discovery of the new gas as above outlined was made nearly a year and a half ago, on March 10, 1897. On the following day the pressure had increased to nearly five millionths, while the time of cooling of the thermometer, instead of diminishing as usual with increase of pressure, had risen from 177 seconds to 245 seconds, showing that the new gas had largely disappeared. This was subsequently found to be due to absorption by the phosphorus pentoxide used in desiccation.

Long continued moderate heating of the pulverized glass caused the evolution of some air, much carbon dioxide and hydrogen, some carbon monoxide, and more of the new gas. The selective absorption which occurred on cooling was confined almost wholly to the hydrogen and new gas. After further moderate heating and thorough exhaustion, I raised the temperature, continued the exhaustion, and got the results embodied in the curve, *g h*, showing that much of the new gas was present; the conductivity at 0·38 of a millionth, the last station in the curve, being twenty-seven times that of hydrogen. Several days of high heating, with frequent exhaustion, failed wholly to deprive the pulverized glass of its new gas, though the output was greatly diminished. For this and other reasons, I believe that the new gas resides in and not simply on the surface of glass.

To make sure that the apparatus was not deceiving me, I sealed off the combustion tube, heated the vacuous parts several hours by means of air and water baths as before indicated, admitted air dried over phosphorus pentoxide, exhausted step by step, and got the data for the "small bulb" air-curve shown here and in last year's paper. Evidently I had not been deceived about the presence of a new gas in the pulverized glass. I subsequently exposed this lot of glass several days to the atmosphere, spread out in a thin layer. When tested again after this exposure, it yielded the new gas both before and after heating, as freely as at first. This rejuvenation of pulverized glass by exposure to the air was fully confirmed with another lot made from common window-glass; and in connection with the results obtained by the diffusion of air, hereafter described, leaves no room for doubt that the new gas is a constituent of the atmosphere.

Pulverized glass appears to begin evolution of the new gas as soon as the atmospheric pressure is reduced. In one case, while making a slow preliminary exhaustion, I tested the air which remained when the pressure was still 132 mm.; and, to my great surprise, found it contained not only a trace, but a considerable quantity of new gas. The amount increased rapidly as the pressure was further reduced. This leads to the belief that finely pulverized glass gives up the greater part of its new gas on simple reduction of pressure to a low point, and without heating; somewhat as palladium gives up occluded hydrogen.

Several other substances than glass were examined, and nearly all found to contain the new gas. A specimen of old charcoal, made from pine wood sawdust by long exposure to a bright red heat, yielded, as was expected, comparatively large quantities of several gases when heated in vacuum. At some stages of the evolution these were rich in the new gas.

It would seem easy in such cases to remove the diluent gases by oxidation and absorption; but it is not. After making the necessary additions to my apparatus, I made many attempts of this kind. The reagents used were in large excess on account of the very small quantities of gas treated; so that some of the observed results may have been due to impurities. Cupric oxide and lead chromate evolved gases of their own almost indefinitely on high heating in vacuum, and then freely absorbed carbon dioxide and moisture at a lower temperature. Soda lime dried in vacuum in the presence of phosphorus pentoxide was almost indifferent to carbon dioxide. All the reagents named, especially phosphorus pentoxide, absorbed the new gas; and all but the latter gave it up again on heating.

A specimen of very fine white silicious sand, when heated in vacuum, gave a large quantity of gas consisting principally of hydrogen and hydrocarbons, with a considerable amount of the new gas. Some of this mixture was exposed successively to the action of red hot cupric oxide, soda lime, and phosphorus pentoxide. By this treatment the gases were reduced to less than three per cent. of their former volume. The residue was not very rich in the new gas, because of the absorption of the latter by the soda lime and phosphorus pentoxide, as I afterward learned; but I have shown the curve, *o p*, of its heat conductivity, because the pressure was carried to a lower point than in any other case. At the last station in the curve, representing a pressure of 0·12 of a millionth, the conductivity was equal to that of 5·1 millionths, or forty-two times as much as hydrogen. From this it seems reasonably certain that the curve, *e f*, if carried to as low a pressure, would have shown a conductivity at least a hundred times greater than hydrogen. And yet the new gas in that experiment must have been very far from pure on account of the continuous evolution of ordinary gases, as shown by the rise of pressure and loss of conductivity during the next few hours.

It will be observed that when the new gas was present, the form of the conductivity-curves was very different from those of the known gases; the effect of the new gas becoming more prominent as the pressure was reduced. I do not doubt that this was due to the interference of the heavier and slower moving molecules of the ordinary gases always mixed with the new gas. In last year's paper I described the same effect found in a mixture of carbon dioxide and hydrogen. When the new gas is obtained in a state of purity, I expect to find its curve of heat conductivity similar to those of hydrogen and helium, but with immensely increased ordinates.

Believing that the new gas is very much lighter than air or hydrogen, and may therefore be separated from

* W. E. Griffis, "Japan: In Story, Folk-Lore, and Art," p. 79.

† "Japan: In Story, Folk-Lore, and Art." p. 43.

‡ Read before the American Association for the Advancement of Science, August 23, 1898.

the atmosphere by successive diffusions, I have spent several months in experiments with this end in view. Quite recently my efforts have been crowned with most promising success. The difficulty has been to find a suitable porous septum; one free from holes, and sufficiently fine grained to prevent more than a very slow passage of air, while a considerable surface is exposed to the atmosphere on one side and to a fairly good vacuum on the other. Many substances were tried. India rubber gave encouraging results, but was capricious, and very slow. The best results have been obtained with porous porcelain having its superficial pores nearly closed by suitable treatment. A tube of this kind, closed at one end, and exposing rather more than five square inches of surface to the air, was connected with the apparatus, and the whole kept exhausted to a pressure of 1·3 mm. About 19 c. c. of gas was diffused per hour. After 36 hours the diffusion tube was shut off, the exhaustion continued, and data for the curve, *m n*, obtained. It was found impracticable to carry the exhaustion below six millionths, because of the presence of moisture, which interfered with the action of the pump, no desiccating agent being used. As both phosphorus pentoxide and soda lime absorb the new gas, they cannot be used for desiccation. If the exhaustion had been carried as far as in the curve, *o p*, it is probable that a higher conductivity than in that curve would have been shown; i. e., a conductivity more than forty-two times that of hydrogen, or something like a hundred times that of air. Here we have the heat conductivity of air at very low pressure, increased something like a hundredfold by one diffusion. I have not yet tried a secondary diffusion, but feel confident that successive diffusions of air will afford a practicable means of obtaining the new gas in a state of approximate purity.

Now let us discover, if possible, the meaning of the extraordinary heat conductivity of the new gas. I have tabulated the molecular weight, density, specific heat, mean molecular velocity, and heat conductivity of hydrogen, helium, carbon monoxide, air, and carbon dioxide, which are the known gases represented in the curve chart. For easy comparison, I have taken not only the density, but the specific heat, mean molecular velocity, and heat conductivity of hydrogen as unity. The similarity of values in the fifth and sixth columns, for molecular velocity and heat conductivity, is striking. On the chart, the curves for carbon monoxide, air, and carbon dioxide are evidently too high to correspond well with the relative values of molecular velocity in the fifth column; but these curves represent only the last 50 millionths of the complete curves. By following these back to 500 millionths, which is still a rather small pressure, and taking their values at intervals of 10 millionths from no pressure upward, we obtain as a mean of all these values for each gas the quantities shown in the sixth column. These agree fairly well with the molecular velocities.

COMPARISON of GASEOUS PROPERTIES.

1	2	3	4	5	6
Gas	Molecular weight	Density D	Relative specific heat	Relative molecular velocity $\frac{1}{\sqrt{D}}$	Relative heat conductivity
Etherion	? 0.0002	? 0.0001	6000.?	100.?	100.
Hydrogen	2.	1.	1.	1.	1.
Helium	4.	2.	?.300	0.71	0.78
Carbon monoxide	27.8	13.9	0.072	0.27	0.33
Air	28.8	14.4	0.069	0.26	0.32
Carbon dioxide	43.8	21.9	0.064	0.21	0.21

I offer the suggestion that the relatively high conductivity of the last three gases at the low pressure shown in the chart is due to the dissociation of some of their molecules by unobstructed impact on the walls of the containing vessel, recombination being more and more retarded as the pressure is lessened, because the greater separation of the molecules reduces the frequency of collisions. Helium, perhaps because it is monatomic and therefore incapable of dissociation, has a nearly straight curve like hydrogen; and its ratio, given in the sixth column, varies but little throughout the whole range observed, which was more than a thousand millionths. I have taken the density of helium at 2; but Prof. Ramsay finds it a little less than this when purified as far as possible by repeated diffusions. This makes its relative molecular velocity a little more than 0·71, and brings it still closer to the observed value of its heat conductivity.

From the foregoing, we may reasonably conclude that the heat conductivity of gases at low pressures, and their mean molecular velocities, are closely related. Hence, if we can learn the heat conductivity of an otherwise unknown gas, we can form some idea of its mean molecular velocity; and from this, of its specific heat, density, and molecular weight.

As before indicated, the heat conductivity of the new gas at very low pressure, even when mixed with a large proportion of other gases, is something like a hundred times that of hydrogen. I shall not be surprised to find the conductivity of the pure gas a thousand or more times greater than that of hydrogen; but let us be conservative, and for the present purpose call it a hundred times, and see what follows. I have given it this value at the head of the sixth column.

If my inference that the heat conductivity and molecular velocity of gases are directly related is correct, then the molecular velocity of the new gas will be 100 times that of hydrogen, as shown at the head of the fifth column. As is well known, the mean molecular velocity of a gas varies directly with the square root of its absolute temperature, and is independent of pressure. The mean molecular velocity of hydrogen at the temperature of melting ice has been found by calculation to be 5,571 feet per second. Hence the mean molecular velocity of the new gas at the same temperature will be 557,100 feet, or more than 105 miles per second. At anything like this molecular velocity, it would be quite impossible for a gas to remain in the atmosphere, unless the space above also contained it. A velocity of only about seven miles per second, if unchecked except by gravitation, would be sufficient to project a body from the earth permanently into space. Even at a temperature very close to absolute zero, the new gas would have sufficient molecular velocity to escape from the atmosphere.

Again, inasmuch as the molecular velocities of gases vary inversely as the square roots of their densities, it follows from our assumption of its molecular velocity that the density of the new gas is only the ten thousandth part that of hydrogen, as shown at the head of column 3. This is the one hundred and forty-four thousandth part the density of air. It is generally believed that the gases of the atmosphere distribute themselves in the long run, each as though the others were absent. Hence the new gas must extend a hundred and forty-four thousand times as high as the heavy constituents of the air, to bring about the same proportionate reduction of pressure, even if gravitation remained constant at all distances from the earth; but the restraining influence of gravitation on the expansion of the atmosphere diminishes as the square of the distance from the earth's center increases. It is evident, therefore, without a mathematical demonstration, that the new gas being present in the atmosphere must extend indefinitely into space without great loss of pressure. This is only another way of stating the result of its assumed molecular velocity. Now there is no doubt that the new gas exists in the atmosphere, though probably in very small proportion; perhaps much less than a millionth. Hence it seems really probable that it not only extends far beyond the atmosphere, but fills all celestial space at a very small pressure. In recognition of this probability, I have provisionally named it aetherion or etherion; meaning "high in the heavens." Its symbol will naturally be Et.

I am aware that strong objections may well be raised to the hypothesis of an inter-planetary and interstellar atmosphere; but I can see no escape from the conclusion I have drawn, if I am not mistaken in my premises.

The estimated relative specific heat of etherion appears at the head of the fourth column, based again on the assumed relative molecular velocity. In estimating the specific heat, I have not made it inversely proportional to the density, as would be required by Dulong and Petit's law, giving a value ten thousand times that of hydrogen; but have used the formula suggested by Prof. Risteen in his work on "Molecules and the Molecular Theory," which requires that the product of the specific heat and molecular weight of gases shall vary with the number of degrees of freedom of their molecules. I have assumed as probably true that etherion is monatomic, with atoms possessing only three degrees of freedom.

Of course the values I have estimated for the molecular weight, density, specific heat, and molecular velocity of etherion are intended only to indicate the order of magnitudes we may expect to find on further investigation; and it must not be forgotten that they are based on two assumptions: first, that the heat conductivity of etherion is one hundred times that of hydrogen; and second, that the ratio of heat conductivity and mean molecular velocity is the same for all gases. As before indicated, I expect to find the heat conductivity of etherion much higher than the value here assigned to it. If so, the real values of its other attributes will be still more startling than those here given. The second assumption, while by no means proved, seems at least a good "first approximation" to the relation between heat conductivity and molecular velocity in gases.

There is some evidence that etherion is a mixture of at least two different gases. In the course of my experiments I have met with a great many specimens, obtained in various ways from various sources; but always mixed with a very large excess of other gases. Some specimens were almost wholly absorbed by the phosphorus pentoxide at first used for desiccation. Others were but partially absorbed; the absorption being very rapid at first, but in an hour or two dwindling to nothing and leaves a residue of gases permanently showing, by their heat conductivity, the presence of a very considerable amount of etherion. Soda lime absorbed etherion, but much less freely than phosphorus pentoxide, and gave it up again on heating. The gas thus recovered was but little if at all affected by phosphorus pentoxide.

In one experiment, the gases evolved from ten ounces of pulverized window-glass, both before and after heating, were passed through coarsely pulverized soda lime and then over fresh phosphorus pentoxide. Not a trace of etherion remained. The same result was obtained when another lot of the silicious sand already referred to was used as the source of etherion.

I will venture the conjecture that etherion will be found to consist of a mixture of three or more gases, forming one or more periodic groups of new elements, all very much lighter than hydrogen. If this proves true, I purpose to retain the present name for the lightest one.

The transmission of radiant energy through space has always been to me a fascinating phenomenon, and I have indulged in much speculation concerning the ether—that mysterious something by means of which it is effected. The remarkable properties assigned to the ether from time to time in order to account for observed phenomena have excited my keen interest; but I have long entertained the hope that some simpler explanation of the mechanism involved will be found. To me a less strain of the imagination is required in the assumption that, instead of a continuous medium, gaseous molecules of some kind, endowed perhaps with a mode or modes of motion at present unknown to us, are the agent of transmission; a gas so subtle and existing everywhere in such small quantity that it has escaped detection.

Perhaps the molecular hypothesis of the ether has proved so attractive to me because it supports the hope that we may some time compass the perfect vacuum—a portion of space devoid of everything. Such a vacuum would be opaque to light, and gravitative attraction could not, I believe, act through it. It might afford a new point of view from which to study the profound mystery of gravitation; an outside point.

The late De Volson Wood (Phil. Mag., Nov., 1885) considered the question of a gaseous ether mathematically, and deduced certain necessary properties of the hypothetical gas; chief among which were exceedingly small density and exceedingly high specific heat. Possibly we are about to find a gas which will fulfill the required conditions. It may be etherion, or its lightest constituent if it turns out to be a mixture. I venture to express the hope that etherion will at least account for some phenomena at present attributed to the ether.

On account of the presumably extreme smallness of its molecules as compared with those of glass, etherion probably passes through the latter when any considerable difference of pressure exists on opposite sides, though the passage may be very slow. It seems to be condensed or compressed in glass as before indicated, and may evaporate on the side of lower pressure, and be absorbed on the side of higher pressure, after the manner of hydrogen in passing through palladium. In my own experiments the heat transmission ascribed to the ether may be due to the presence of the new gas inside the bulb. A small fraction of a millionth would be sufficient, and this might escape detection by the pressure gage, on account of the necessary compression in the gage head causing absorption by the glass. Again, etherion must always be present to some extent in all "vacuum tubes" (as well as in my own conduction bulb) on account of its long continued evolution from glass; and may be the medium of propagation of the Roentgen rays in the vacuum glass and air.

OSMIUM.

THE heaviest thing in the world is the metal osmium, the bluish white metal with violet luster, which Mr. Smithson Tennant discovered ninety years ago in the residue from dissolved platinum ores. This metal has a specific gravity of 22·477, that of gold being 19·265, lead 11·367, iron 7·79, and lithium, the lightest, only 0·594. The French chemist Joly determined that osmium is likewise the most infusible of metals. It could never be made to yield to the oxyhydrogen flame which makes platinum and iridium run like water. But Joly has been subjecting osmium to the excessively high temperature of the electric arc, which Moissan has of late employed successively in the manufacture of diamonds. Under this fierce heat the rare metal ruthenium, which used to be deemed all but infusible, readily melts. But osmium remains refractory, there being apparent only the faintest traces of fusion. On this account osmium cannot be prepared in sufficient quantity to make it very useful in the arts. But its alloy with iridium, which defies the acids, is of some value, nothing better having been found wherewith to tip gold pens. Being non-magnetic, its employment for the bearings of the mariner's compass has been advocated.—Popular Science News.

ALUMINUM CROWNS.*

By A. E. PRESTON, D.D.S., Delevan, N. Y.

A FEW weeks after making my first investment in aluminum caps a gentleman presented himself in my office with a number of decayed teeth, which he wished me to save if possible. One, a lower second molar, was in very bad shape for holding fillings, and I suggested to him that it would be a good tooth to crown with a gold cap. But the idea of placing so much money into one tooth I saw at once was not congenial to his ideas. Here, thought I, is a chance to try one of those new crowns, so I brought forward one of my aluminum caps, and, setting a figure upon it which I thought he would be willing to stand, I told him that I here had something which would be just what he wanted.

After a few questions concerning the metal, its color, keeping qualities, durability, etc., he consented that I should put it in place. I at once proceeded exactly as I would with a gold cap, and found that this material was even more easily manipulated than a gold cap, on account of the pliability of the metal.

After shaping and fitting the cap and tooth to each other, I allowed the patient to bite, at first gently, then afterward more firmly, until the bite was closed, thus doing nearly all the swaging of the cusps and intervening depressions himself by the act of occlusion.

These caps, you remember, are swaged in the first place, and are of nearly uniform thickness in every part, the same as swaged gold caps, and do not have built up or filled in cusps, as our homemade crowns usually do. Hence the ease with which the occlusion is made without the use of impressions, bites, or articulators; in fact, the whole operation occupied but a little more time than it takes to make a good amalgam filling.

This was nearly three years ago; since then I have seen the tooth several times, the last time being the first week of this present month. Everything was in good condition; the occlusion perfect, the color the same as when new, and the patient expressed the same praise for the work you so often hear of a well fitting gold cap: "Doctor, that is the best tooth in my mouth."

Case No. 2 was not so fortunate in its results. The patient, a young lady, presented a lower third molar, which had been filled and refilled, and was then broken down nearly to the gum margin. She thought the best thing for the tooth was extraction. But I suggested placing an aluminum cap, which would be much less expensive than gold, and seeing what the result would be. So that course was pursued. In this case I had to build up nearly all of the crown, which I did by undercutting the remaining dentin and filling the cap with cement and then pressing it to place, after having secured a good fit and articulation. The pulp was alive, and responded for few moments to the action of the cement, as a healthy pulp nearly always does. This crown did good service for nearly a year, when a small break occurred in the margin of the grinding surface, caused by biting too forcibly upon a hard kernel of popcorn. The break seemed trivial and very easy to mend; but now comes the part which shows what ignorance and thoughtlessness, combined with a desire to experiment, will sometimes do. I enlarged the opening with an engine bur, made a nice undercut in the cement underneath, and filled the cavity with

*Read before the Eighth District Dental Society, Buffalo, N. Y., April 26, 1898.—From The Aluminum World.

amalgam; then dismissed my patient, telling her that the crown was now as good as new.

In the afternoon she returned bearing in her hand a crumpled, rotten, distorted piece of metal, which had no resemblance to my handsom aluminum cap; but such it nevertheless was. This was her story: After eating dinner she sat down to talk with her husband, and remarked that that crown seemed loose. She placed her fingers in her mouth, and saying, "It is loose," removed it in her hand and immediately dropped it, exclaiming, "Oh, it's hot! It burned me." "What are you giving us?" remarked her husband, and at the same time picking the cap from the carpet. He also dropped it, saying, "Gee whiz! It is hot. It's a wonder it didn't burn your mouth." That's just what I said also when she told me the story.

Now, one thing I want to know is, why didn't it burn her mouth? Were the fluids of the mouth keeping it cool, or was it waiting for a contact with the atmosphere to start up the heat action? I learned one thing that I ought to have known before; that is, that mercury will unite with aluminum just as it will with silver or gold, and that amalgam should not be used to patch aluminum caps. I don't suppose any other dentist ever makes any of these little blunders, and that is why so few of them are ever brought to our attention. We prefer to tell of some of the brilliant successes we have had with some new appliance, or some intricate operation performed that has brought us fame and our names into prominence. Nevertheless the little things of daily office practice, when remembered, help to make our work more successful.

I replaced the destroyed aluminum cap by another of the same material, upon the good, solid cement crown, which was well preserved, and it is doing good service to-day.

My experience with aluminum caps has been very limited, but they have proved to be successful when rightly placed. I would not use them when I could use gold just as well, yet I believe they are worthy of a place in crown work.

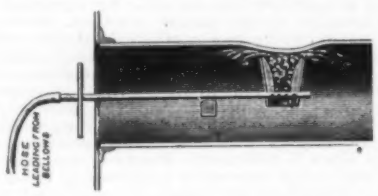
SETTING BACK BULGES IN FURNACES.

By a BOILER INSPECTOR.

THE usual method of setting back bulges in furnaces is to apply a fire below, and then to force the fire by a blast led from a rivet-fire bellows. After the bulge has been sufficiently heated the fire is withdrawn, and a jack applied to force back the bulges. This must be quickly done, or else the bulge will have cooled down so much that it cannot be forced back. In the limited room for working, it is always an awkward and unpleasant job. In removing the fire it often gets spilled about, and the necessary packing to keep it up to the bulge has also to be cleared out of the furnace, and during the time this is being done the heated part is rapidly cooling. For reheating the fire has again to be packed up against the bulge, and the cycle of operations repeated till the furnace is sufficiently restored to shape. The whole of the work has invariably to be performed at the place where the boiler is worked, with what appliances can be most conveniently found, often by workmen who have had no experience with this class of work.

The writer designed the method shown on annexed sketch to get over some of the difficulties connected with this job, and he believes it is an improvement on the usual methods. The whole of the materials required can generally be got, even in the most out-of-the-way places, with little trouble.

A wrought-iron pipe, about an inch in diameter, is fitted to the bottom of a wrought-iron bucket, as shown. The end, which passes a short distance through, being plugged up, the upper part inside the bucket perforated by a slot or several holes, and the bucket lined with fireclay, a cross handle to steady the whole is clipped on near the other end of the pipe, that end being connected, preferably by a hose pipe, with the rivet-fire bellows. The fire is kindled and got properly started before inserting in the furnace. A suitable crossbar with a notch in it is inserted in the furnace tube. The fire can be quickly placed in position under the bulge, and by grasping the cross handle and the end of the tube, can be quickly manipulated as required. It can be quickly withdrawn, and laid down well back from the boiler front, so as to be out of the



way, and the jack applied to the bulge with the minimum loss of time.

A 15 to 20 ton hydraulic jack is the best to use. A small piece of ¼ inch or ⅝ inch plate, heated to redness and bent to the circle of the furnace, should be put on the top of the jack to prevent it from cooling and marking the furnace plate. A larger plate, bent to the circle of the furnace, should be placed below the jack to distribute the stress. If any packing is required to bring the jack against the bulge, a single block of good hard wood of suitable thickness should be used. The bulge should be pressed back by the jack; at the same time a little judicious flogging on the water side will make it go back easier.

After the furnace has been restored as near as practicable to original shape, the parts that have been set back should be heated to a dull red to remove any local stresses that may have been set up in the plates. As the fire can be easily shifted about to any desired part of the furnace, this can be easily done.—Engineering.

OLD METHODS OF CROSSING RIVERS BY PONTOONS.

MODEL OF A PONTOON OR PORTABLE BOAT FOR PROMPTLY THROWING A BRIDGE ACROSS A NARROW RIVER.

THIS machine can be used very advantageously, provided that the river over which it is desired to pass troops is not more than from 40 to 45 feet in width. It consists of a pontoon, *A*, which is provided with three sections of a bridge, *B*, *C*, and *D*. These latter are connected by joints, *E* and *F*, so that there is thereby formed a sort of double drawbridge that may be raised and lowered, as need may be, by the ropes, *G*, and the double pulleys placed at the upper ends of the side posts, *H*.

The portion of this bridge marked *C*, which is that of the center, may, by means of the pivot, *I*, be put in two directions upon the pontoon. In order that it may occupy less space, it remains lengthwise when the pontoon is on the move, but is placed crosswise when it is desired to form the bridge. The two other portions, *B* and *D*, fold upon one another and always upon the one marked *C*; and, to this effect, the joints of the portion marked *D* are higher than those of the portion marked *B*. All the pieces of this bridge and those that may be added thereto in order to strengthen it as well as the pontoon or boat, *A*, are loaded upon a four-wheeled vehicle made for the purpose, as shown in the figure, and upon which the machine can be easily carried from one place to another. When it is desired to make use of it, all that is to be done is to put the boat, *A*, into the water, anchor it in the middle of the river, and, after setting up the side posts, *H*, and passing the ropes, *G*, over the pulleys, to lower the portions, *B* and *D*, and thus form a bridge of the width of the river.

All this maneuver is effected in a very short time. Thus one can, with this machine, easily conceal his march and the construction of a bridge, and allow troops to pass over it for surprising the enemy, or for any other expedition that one may judge proper.

MODEL OF A PONTOON FOR CROSSING THE MOAT OF A BESIEGED PLACE, PROVIDED THAT THE WATER WITH WHICH IT IS FILLED IS STILL.

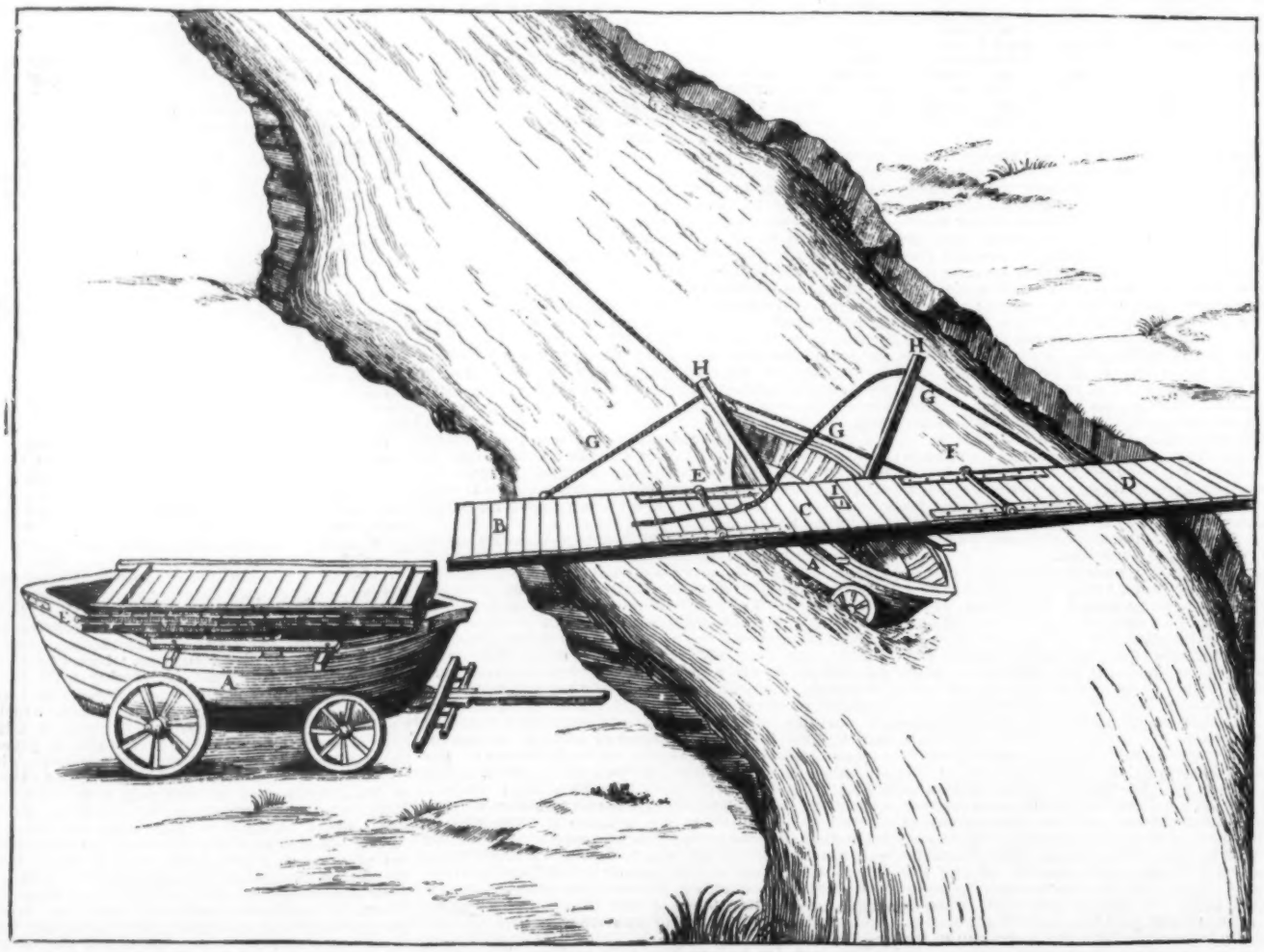
In the siege of places where the situation does not permit of drawing off the water of the moats or of conveniently filling the latter in there may be used the present machine, by means of which one will be able to cross the moat in order to place a mine or to ascend to an assault.

The boats or pontoons that I propose for this purpose are provided with wheels, as the figure shows, and, during carriage, are united in pairs, one on top of another.

When it is desired to use them, they are assembled at the head of the moat, and afterward, in measure as they are put into the water, they are connected with each other end to end and pushed to the side of the escarpment where it is desired that they shall end. The first boats placed in the water are pushed by the following ones in succession until they form a bridge of the necessary length over the moat.

The wheels with which these boats are provided serve not only for moving them from one place to another, but are also of great service when it is desired to put them in water or to remove them therefrom, provided, moreover, that a glacis be formed at the descent to the moat—a matter of no difficulty. And, this glacis once formed, the laborers employed in the construction of the bridge will be able to work in the moat under cover from the fire of the besieged, and, without greatly exposing themselves, to push their boats into the water, even in broad daylight, provided they are favored by a hotter fire on the part of the besiegers.

Nevertheless, it is better to take advantage of the darkness of the night for performing this maneuver, in that the enemy can then throw fewer obstacles in the way, and that even the bridge being formed during the night, one is in a state to surprise the enemy



MODEL OF A PONTOON OR PORTABLE BOAT FOR PROMPTLY THROWING A BRIDGE ACROSS A NARROW RIVER.

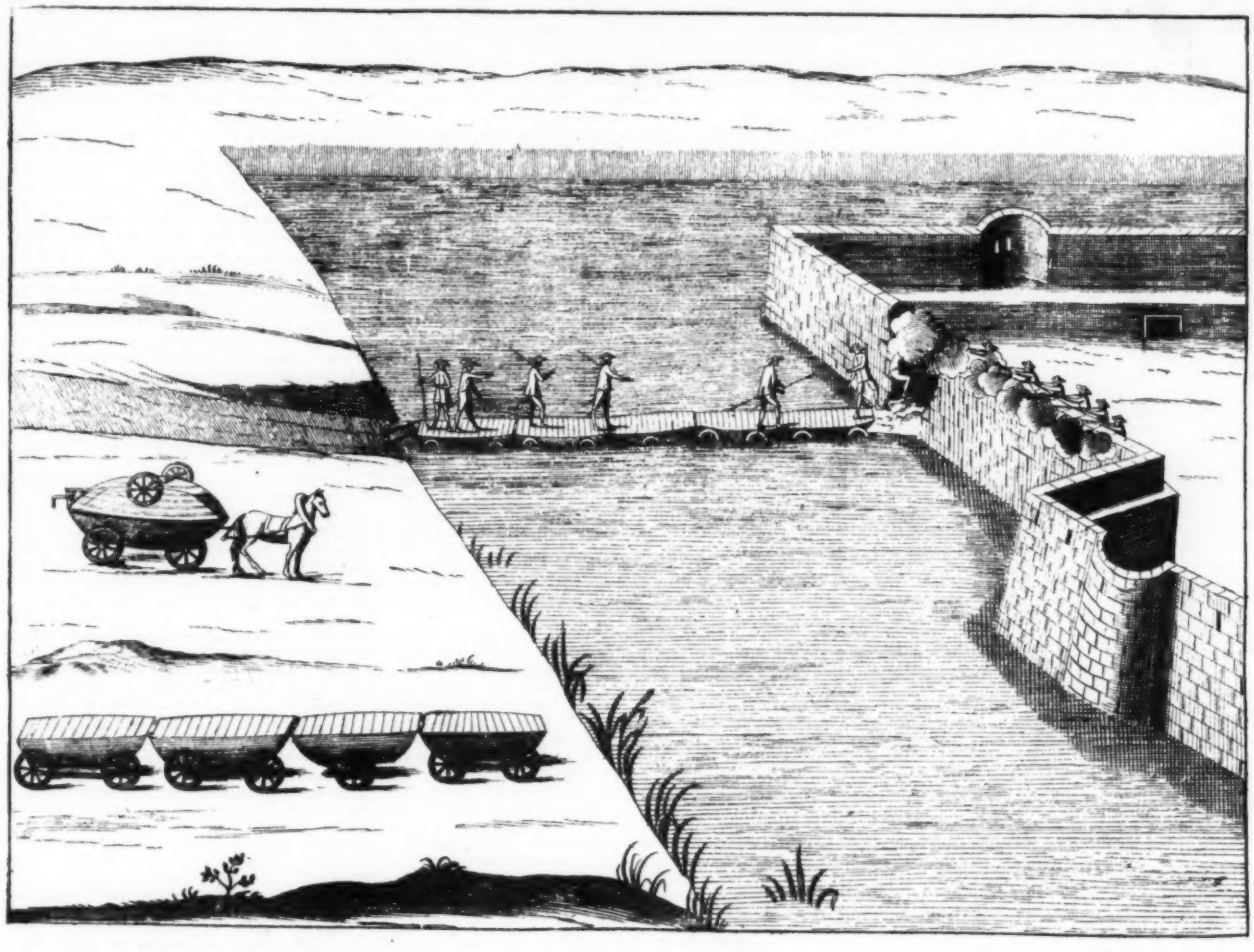
at daybreak, or to act before he has had time to disrupt your bridge.

METHOD OF CONSTRUCTING A BRIDGE OF CASKS IN ORDER TO CROSS A CANAL OR SMALL RIVER IN THE PRESENCE OF THE ENEMY.

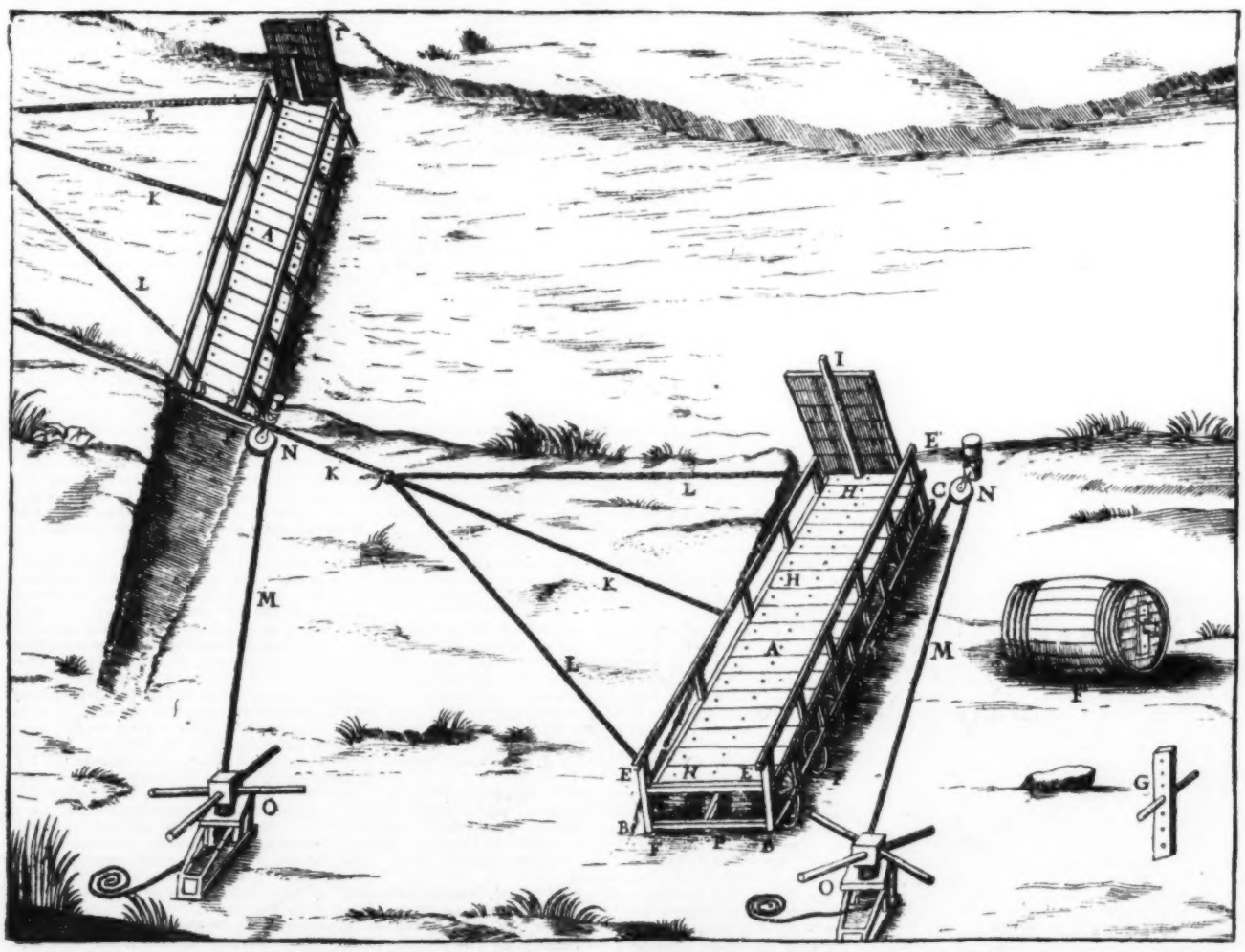
On the bank of the canal, on the side of which you are master, and upon the ground that you have taken care to form into a glacis, construct the bridge, *A*, of the necessary length, that is to say, as long as the canal is wide.

You form this bridge (1) of long pieces of wood, or beams, *B C*, which are assembled with the cross pieces, *D*, and the uprights, *E*; (2) of the casks, *F*, which are placed in the spaces between the beams, *B*, and are attached thereto by a sort of pivot, *G*; (3) of the planks, *H*, which are nailed to the beams, *C*; and (4) of the pontlevis, *I*, which is embattled and placed at the end of the machine on the side that faces the enemy.

The casks, *F*, are attached to the beams, *B*, by their pivot, *G*, in the form of rollers, in order that the entire machine can be thrown into the canal with more facility when the time comes for it; and the pontlevis,



MODEL OF A PONTOON FOR CROSSING THE MOAT OF A BESIEGED PLACE, PROVIDED THAT THE WATER WITH WHICH IT IS FILLED IS STILL.



METHOD OF CONSTRUCTING A BRIDGE OF CASKS IN ORDER TO CROSS A CANAL OR SMALL RIVER IN THE PRESENCE OF THE ENEMY.

I, which is made bulletproof, serves to cover the soldiers who are upon the bridge until it is judged proper to lower it in order to pass and to charge the enemy.

After this machine has been constructed and you desire to use it, you move it from one side of the canal to the other by means of the ropes, *K*, *L*, *M*, the pulley, *N*, and the capstan, *O*.

All the ropes being arranged as shown in the figure, the one marked *K* being attached by one end to an anchor fixed in the middle of the canal and the one marked *M*, which passes over the pulley, *N*, being attached to the end, *P*, of the bridge and wound around the capstan, the latter is revolved by manual power, and, in measure as it revolves and winds up the rope, *M*, it moves the bridge into the water and causes it to cross the canal.—From Recueil d'Ouvrages Curieux de Mathematique et de Mecanique, 1733.

ELECTROPLATING ON WOOD.

By C. F. BURGESS.

AN electrical industry of considerable importance is that which depends upon the deposition of metals from aqueous solutions of their salts by the electric current, for the purpose of imparting an ornamental or protective coating. The increasing uses which are being found for such coatings, and improvements in the processes for applying them, are contributing to a rapid growth of this industry.

This work is confined almost entirely to the deposition of a metal or alloy of metals on metallic surfaces, although the deposition of metals on non-conducting substances is practiced to a limited extent in such processes as the manufacture of parabolic reflectors, in which the metal is deposited on a prepared glass form, from which the coating is afterward removed, and in the production of electrotypes, which are made in a similar manner, wax instead of glass forming the mould. Most books treating of the electro-deposition of metals refer to methods for coating leaves, flowers, wood, and other non-conducting substances, and give various methods for so doing. These methods are usually so expensive and difficult of execution that they cannot be used extensively, though it is reported that in Germany the plating on wood has become an industry of some importance.

There is little question that, if an adhesive coating of metal could be easily and cheaply applied to wood and similar materials, a considerable demand for such work might be found. Designs carved in wood and coated with copper and brass would compete with the rather expensive copper, brass, and bronze castings used for ornamental purposes, and picture frames and mouldings could be given a true metallic surface instead of the metallic appearance which is usually imparted by means of metallic paints, which have little durability. The wooden handles of instruments such as are used by surgeons and dentists, when coated with nickel, would be both light and easily cleaned, without the annoyance of the handles becoming loose and cracking when subjected to alternate wetting and drying. Innumerable instances might be mentioned where a metallic surface is desirable, where great strength is not necessary and where lightness is advantageous, in which the electroplating process might find application.

The prime requisite for producing such a deposit electrolytically is that the body to be coated shall have a conducting surface, and it is with the formation of such surfaces that the various processes have to deal. After such surfaces have been obtained the electrodeposition is quite simple.

Electrotypers obtain such a surface by applying a conducting graphite to the wax mould, but such surfaces not only require considerable care in application, but they are not adhesive, which, of course, is desirable in that work, but would be a drawback if a permanent coating is required. The application of gold leaf and metallic powders is open to the same objection. An ideal coating would be one in which the fibers are thoroughly impregnated with a metal, and it is with the view of forming such a coating that the following processes are used.

As the metal in a liquid state cannot be absorbed by the wood, recourse must be had to the soluble salts of metals. By immersing the wood in solutions of such salts, the surface will become impregnated with the metal, which, however, is not in such a condition that it will conduct the electric current, for there are no chemical compounds which will offer sufficient conductivity for the purpose in view. The next step then is to change the metal into its elementary condition, which may be accomplished by a reduction process.

The usual method of recovering a metal from a compound is by the use of a reducing agent, such as carbon, in the presence of a high heat, but such process is prohibitive on account of the action of the heat on the wood surface. For this reason an easily reducible salt must be used, which will not require the application of a high temperature to effect the liberation of the metal; such salts being those of gold, silver, and platinum.

A typical process of such a nature is that which employs a solution made as follows:* 1·5 g. caoutchouc and 4 g. wax are dissolved in 10 g. carbon bisulphide, and this is mixed with solutions of 5 g. phosphorus in 60 g. carbon bisulphide and 4 g. powdered asphaltum in 5 g. turpentine. After immersing the wood in this solution and drying, it is dipped in a solution of 2 g. of silver nitrate in 600 g. water until the surface assumes a dark metallic appearance, and after rinsing in water it is finally dipped in a solution composed of 10 g. gold chloride in 600 g. water, after which it is ready to receive the electrolytic deposit.

A somewhat similar method is the employment of a solution of chloride of gold or platinum in sulphuric ether, to which a solution of sulphur in some heavy oil is added. On slightly heating this compound a sufficient consistency is attained to allow a film being laid on the surface to be plated. The object treated in this way is moderately heated in a muffle until sulphur and chlorine are completely volatilized, the gold or platinum adhering firmly to the surface.†

* L'Electricien, vol. xii., 1896, p. 208.

† London Electrician, 1889, p. 110.

In a recent paper by Cowper-Cowles* on the electrolytic process for the manufacture of parabolic reflectors, a simple method is given for rendering glass surfaces conducting, which might possibly be applicable to surfaces of wood. It is as follows: The surface is dipped into a solution consisting of 0·5 per cent. of silver nitrate, 0·5 per cent. of caustic potash, and 0·25 per cent. glucose.

None of these methods have been tried by the writer, but it is quite evident that they have one or more of the following objections: expensive materials, danger to workmen, and time and care necessary for the operation. With the view of obtaining some process for obtaining this first metallic coating, which should be free from these objections, some work was carried on in the electro-chemical laboratory of the University of Wisconsin, and with quite satisfactory results.

The purpose was to employ materials less expensive than the silver and gold salts, and to effect the reduction by utilizing the reducing action at the cathode of the electrolytic cell. The intensity of the reducing action at the cathode depends upon various conditions, such as current density and nature of electrolyte, and is due to liberation of the materials which exist in the solution as the electro-positive ions. If a solution of a metal salt is used in which the metal is the positive ion, that metal will be deposited with a reasonably low current density, and little or no reducing action will occur. If the current density be increased so that hydrogen is liberated, or if a solution be used in which hydrogen is the positive ion, the well known reducing action of hydrogen may be noted. If a potassium or sodium salt be used in the electrolyte, the reducing action is much more marked.

The intensity of the reducing action at the cathode may be taken as approximately proportional to the amount of polarization at that electrode, when unattackable electrodes are used. Some measurements which were made to determine these values gave the following results. Employing carbon electrodes, the maximum cathode polarization was found to be, with NaCl, 1·00 volt; with NH_4Cl, 0·73 volt; with HCl, 0·32 volt; with KOH, 1·11 volt. These figures would indicate that the potassium and sodium salts are the best to use for the purpose in view, and this was confirmed upon trial.

The following is a description of the process by means of which a metallic surface on wood and other non-conducting materials has been obtained. The wood is first immersed in a saturated solution of copper sulphate, and then thoroughly dried, leaving the pores of the surface filled with copper sulphate. On exposing to the action of hydrogen sulphide gas, or immersing it in an aqueous solution of that gas, the copper in the sulphate is changed to copper sulphide. A copper conducting wire of small diameter is then wrapped uniformly around the object, so that each portion of the surface shall be within about one-half inch of the copper conductor, and it is suspended as a cathode in a solution of common salt (NaCl). A current density of a rather high value is used, and the cathode products will decompose the copper sulphide, the action being represented by the following formulæ:

$$CuS + H_2 = H_2S + Cu,$$
$$CuS + Na_2 = Na_2S + Cu,$$
$$CuS + Na + H = NaHS + Cu.$$

Metallic copper is thus set free. This coating is black and without a metallic appearance, but it conducts the current as desired. It forms first at the points of contact of the wire and the wood and gradually spreads over the entire surface, the time necessary for this operation being about ten minutes, using the proper solution and current density. The object may then be transferred to the copper sulphate or other plating bath, where a coating to any desired thickness may be obtained.

The coating thus formed will be an exact reproduction of the surface of the wood, the grain being clearly shown, and will be sufficiently adhesive to stand grinding and burnishing.

The purpose of transforming from copper sulphate to the sulphide is to render the salt insoluble in water. Otherwise, on placing the article in the bath of sodium chloride, the copper sulphate would be redissolved and no continuous coating could be formed. The copper sulphide, on the contrary, is quite insoluble, and it is also more easily reduced to the metallic state.

Copper compounds are preferable to similar compounds of the other common metals, owing to the high conductivity of copper and the less stable compounds which it forms.

In the process just described a separate bath is used for the reduction of the sulphide, but this may be just as readily accomplished in some metallic bath where the metal is deposited simultaneously with the reduction of the sulphide. A potassium copper cyanide solution is such a one that the processes of reduction of the copper sulphide and the deposition of the metal from the solution may be carried on simultaneously, for here the potassium forms the electro-positive ion, while the $CuCy_2$ is the negative. The copper is deposited by a secondary reaction.

A solution of silver nitrate used in place of the copper sulphate will enable the process to be carried on more rapidly, though the greater cost of the silver salt is a disadvantage.

If the material to be plated is one which will expand on absorbing moisture, it will do so when placed in the plating bath. Consequently, after it has received its metallic coating, upon drying it will contract and thus cause the coating to wrinkle up and become loose. This may be avoided by leaving the object in the bath for only a short time; then drying it, and repeating the process until the desired thickness is obtained. Or, the following process, which I have used satisfactorily, may be employed:

The wood is first immersed in hot paraffin, which it readily absorbs, and is thus rendered impervious to moisture. It is then placed in gasoline, which dissolves the paraffin near the surface and renders it capable of absorbing the metallic salt. The trouble caused by expansion is thus entirely removed.

By the above process articles of wood, vulcanized fiber, and hard rubber have been given firm, adhesive coatings of copper, nickel, zinc, silver, etc., which were capable of being polished as readily as though deposited on metallic surfaces, and the process appears to be one which might readily be put to commercial use. It at any rate shows one of the many ways in which the oxidizing and reducing actions which take place at the electrodes of an electrolytic cell may be put to a practical use.—The Electrical World.

* Jour. Inst. Elec. Eng., March, 1898.

[Continued from SUPPLEMENT, No. 1189, page 19069.]

INAUGURAL ADDRESS BY SIR WILLIAM CROOKES, F. R. S., V. P. C. S., PRESIDENT OF THE BRITISH ASSOCIATION.

FURTHER prosecution of these researches must lead to deeper insight into molecular processes and the mode in which they affect the ether; indeed, already valuable theoretic views have been promulgated by H. A. Lorenz, J. Larmor, and G. F. Fitzgerald, on the lines of the radiation theory of Dr. Johnstone Stoney; and the connection of the new phenomena with the old magnetic rotation of Faraday is under discussion. It is interesting to note that Faraday and a number of more recent experimenters were led by theoretic considerations to look for some such effect; and though the inadequate means at their disposal did not lead to success, nevertheless a first dim glimpse of the phenomenon was obtained by M. Fievez, of the Royal Observatory at Brussels, in 1885.

It would be improper to pass without at least brief mention the remarkable series of theoretic papers by Dr. J. Larmor, published by the Royal Society, on the relationship between ether and matter. By the time these researches become generally intelligible they may be found to constitute a considerable step toward the further mathematical analysis and interpretation of the physical universe on the lines initiated by Newton.

In the mechanical construction of Roentgen ray tubes I can record a few advances; the most successful being the adoption of Prof. Silvanus P. Thompson's suggestion of using for the antikathode a metal of high atomic weight. Osmium and iridium have been used with advantage, and osmium anti-kathode tubes are now a regular article of manufacture. As long ago as June, 1896, X-ray tubes with metallic uranium anti-kathodes were made in my own laboratory, and were found to work better than those with platinum. The difficulty of procuring metallic uranium prevented these experiments from being continued. Thorium anti-kathodes have also been tried.

Roentgen has drawn fresh attention to a fact very early observed by English experimenters—that of the non-homogeneity of the rays and the dependence of their penetrating power on the degree of vacuum; rays generated in high vacua have more penetrative power than when the vacuum is less high. These facts are familiar to all who have exhausted focus tubes on their own pumps. Roentgen suggests a convenient phraseology; he calls a low vacuum tube, which does not emit the highly penetrating rays, a "soft" tube, and a tube in which the exhaustion has been pushed to an extreme degree, in which highly penetrating rays predominate, a "hard" tube. Using a "hard" tube, he took a photograph of a double barreled rifle, and showed not only the leaden bullets within the steel barrels, but even the wads and the charges.

Benoit has re-examined the alleged relation between density and opacity to the rays, and finds certain discrepancies. Thus, the opacity of equal thicknesses of palladium and platinum are nearly equal, while their densities and atomic weights are very different, those of palladium being about half those of platinum.

At the last meeting of the British Association visitors saw—at the McGill University—Profs. Cox and Callendar's apparatus for measuring the velocity of Roentgen rays. They found it to be certainly greater than 200 kilometers per second. Majorana has made an independent determination, and finds the velocity to be 600 kilometers per second with an inferior limit certainly of not less than 150 kilometers per second. It may be remembered that J. J. Thomson has found for kathode rays a velocity of more than 10,000 kilometers per second, and it is extremely unlikely that the velocity of Roentgen rays will prove to be less.

Trowbridge has verified the fact, previously announced by Prof. S. P. Thompson, that fluor spar which by prolonged heating has lost its power of luminescing, when reheated regains the power of thermo-luminescence when exposed to Roentgen rays. He finds that this restoration is also effected by exposure to the electric glow discharge, but not by exposure to ultra-violet light. The difference is suggestive.

As for the action of Roentgen rays on bacteria, often asserted and often denied, the latest statement by Dr. H. Rieder, of Munich, is to the effect that bacteria are killed by the discharge from "hard" tubes. Whether the observation will lead to results of pathologic importance remains to be seen. The circumstance that the normal retina of the eye is slightly sensitive to the rays is confirmed by Dorn and by Roentgen himself.

The essential wave nature of the Roentgen rays appears to be confirmed by the fact ascertained by several of our great mathematical physicists, that light of excessively short wave length would be but slightly absorbed by ordinary material media, and would not in the ordinary sense be refracted at all. In fact, a theoretic basis for a comprehension of the Roentgen rays had been propounded before the rays were discovered. At the Liverpool meeting of the British Association, several speakers, headed by Sir George Stokes, expressed their conviction that the disturbed electric field caused by the sudden stoppage of the motion of an electrically charged atom yielded the true explanation of the phenomena extraneous to the Crookes high vacuum tubes—phenomena so excellently elaborated by Lenard and by Roentgen. More recently, Sir George Stokes has restated his "pulse" theory, and fortified it with arguments which have an important bearing on the whole theory of the refraction of light. He still holds to their essentially transverse nature, in spite of the absence of polarization, an absence once more confirmed by the careful experiments of Dr. L. Graetz. The details of this theory are in process of elaboration by Prof. J. J. Thomson.

Meantime, while the general opinion of physicists seems to be settling toward a wave or ether theory for the Roentgen rays, an opposite drift is apparent with respect to the physical nature of the kathode rays; it

becomes more and more clear that kathode rays consist of electrified atoms of ions in rapid progressive motion. My idea of a fourth state of matter, propounded in 1881 (Phil. Trans., Part 2, 1881, pp. 433–4), and at first opposed at home and abroad, is now becoming accepted. It is supported by Prof. J. J. Thomson (Phil. Mag., October, 1897, p. 312). Dr. Larmor's theory (Phil. Mag., December, 1897, p. 506) likewise involves the idea of an ionic substratum of matter; the view is also confirmed by Zeeman's phenomenon. In Germany—where the term kathode ray was invented almost as a protest against the theory of molecular streams propounded by me at the Sheffield meeting of the British Association in 1879—additional proofs have been produced in favor of the doctrine that the essential fact in the phenomenon is electrified Radiant Matter.

The speed of these molecular streams has been approximately measured, chiefly by the aid of my own discovery nearly twenty years ago, that their path is curved in a magnetic field, and that they produce phosphorescence where they impinge on an obstacle. The two unknown quantities, the charge and the speed of each atom, are measurable from the amount of curvature and by means of one other independent experiment.

It cannot be said that a complete and conclusive theory of these rays has yet been formulated. It is generally accepted that collisions among particles, especially the violent collisions due to their impact on a massive target placed in their path, give rise to the interesting kind of extremely high frequency radiation discovered by Roentgen. It has, indeed, for some time been known that whereas a charged body in motion constitutes an electric current, the sudden stoppage or any violent acceleration of such a body must cause an alternating electric disturbance, which, though so rapidly decaying in intensity as to be practically "dead beat," yet must give rise to an ethereal wave or pulse traveling with the speed of light, but of a length comparable to the size of the body whose sudden change of motion caused the disturbance. The emission of a high pitched musical sound from the jolting of a dustman's cart (with a spring bell hung on it) has been suggested as an illustration of the way in which the molecules of any solid not at absolute zero may possibly emit such rays.

If the target onto which the electrically charged atoms impinge is so constituted that some of its minute parts can thereby be set into rhythmical vibration, the energy thus absorbed reappears in the form of light, and the body is said to phosphoresce. The efficient action of the phosphorescent target appears to depend as much on its physical and molecular as on its chemical constitution. The best known phosphori belong to certain well defined classes, such as the sulphides of the alkaline earthy metals, and some of the so-called rare earths; but the phosphorescent properties of each of these groups are profoundly modified by an admixture of foreign bodies—witness the effect on the lines in the phosphorescent spectrum of yttrium and samarium produced by traces of calcium or lead.

The persistence of the samarium spectrum in presence of overwhelming quantities of other metals is almost unexampled in spectroscopy: thus one part of samaria can easily be seen when mixed with three million parts of lime.

Without stating it as a general rule, it seems as if with a non-phosphorescing target the energy of molecular impact reappears as pulses so abrupt and irregular that, when resolved, they furnish a copious supply of waves of excessively short wave length, in fact, the now well known Roentgen rays. The phosphorescence so excited may last only a small fraction of a second, as with the constituents of yttria, where the duration of the different lines varies between the 0·003 and the 0·0009 second; or it may linger for hours, as in the case of some of the yttria earths, and especially with the earthy sulphides, where the glow lasts bright enough to be commercially useful. Excessively phosphorescent bodies can be excited by light waves, but most of them require the stimulus of electrical excitement.

It now appears that some bodies, even without special stimulation, are capable of giving out rays closely allied, if not in some cases identical, with those of Prof. Roentgen. Uranium and thorium compounds are of this character, and it would almost seem from the important researches of Dr. Russell that this ray-emitting power may be a general property of matter, for he has shown that nearly every substance is capable of affecting the photographic plate if exposed in darkness for sufficient time.

No other source for Roentgen rays but the Crookes tube has yet been discovered, but rays of kindred sorts are recognized. The Becquerel rays, emitted by uranium and its compounds, have now found their companions in rays—discovered almost simultaneously by Curie and Schmidt—emitted by thorium and its compounds. The thorium rays affect photographic plates through screens of paper or aluminum, and are absorbed by metals and other dense bodies. They ionize the air, making it an electrical conductor; and they can be refracted and probably reflected, at least diffusively. Unlike uranium rays, they are not polarized by transmission through tourmaline, therefore resembling in this respect the Roentgen rays.

Quite recently M. and Mdme. Curie have announced a discovery which, if confirmed, cannot fail to assist the investigation of this obscure branch of physics. They have brought to notice a new constituent of the uranium mineral pitchblende, which in a 400-fold degree possesses uranium's mysterious power of emitting a form of energy capable of impressing a photographic plate and of discharging electricity by rendering air a conductor. It also appears that the radiant activity of the new body, to which the discoverers have given the name of Polonium, needs neither the excitation of light nor the stimulus of electricity; like uranium, it draws its energy from some constantly regenerating and hitherto unsuspected store, exhaustless in amount.

It has long been to me a haunting problem how to reconcile this apparently boundless outpour of energy with accepted canons. But as Dr. Johnstone Stoney reminds me, the resources of molecular movements are far from exhausted. There are many stores of energy in Nature that may be drawn on by properly constituted bodies without very obvious cause. Some time since I drew attention to the enormous amount of locked up energy in the ether; nearer our experimental grasp are the motions of the atoms and molecules, and it is not difficult mentally so to modify Maxwell's demons as to reduce them to the level of an inflexible law, and thus bring them within the ken of a philosopher in search of a new tool. It is possible to conceive a target capable of mechanically sifting from the molecules of the surrounding air the quick from the slow movers.

This sifting of the swift moving molecules is effected in liquids whenever they evaporate, and in the case of the constituents of the atmosphere, wherever it contains constituents light enough to drift away molecule by molecule. In my mind's eye I see such a target as a piece of metal cooler than the surrounding air acquiring the energy that gradually raises its temperature from the outstanding effect of all its encounters with the molecules of the air about it; I see another target of such a structure that it throws off the slow moving molecules with little exchange of energy, but is so influenced by the quick moving missiles that it appropriates to itself some of their energy. Let uranium or polonium, bodies of densest atoms, have a structure that enables them to throw off the slow moving molecules of the atmosphere, while the quick moving molecules, smashing on to the surface, have their energy reduced and that of the target correspondingly increased. The energy thus gained seems to be employed partly in dissociating some of the molecules of the gas (or in inducing some other condition which has the effect of rendering the neighboring air in some degree a conductor of electricity) and partly in originating an undulation through the ether, which, as it takes its rise in phenomena so disconnected as the impacts of the molecules of the air, must furnish a large contingent of light waves of short wave length. The shortness in the case of these Becquerel rays appears to approach without attaining the extreme shortness of ordinary Roentgen rays. The reduction of the speed of the quick moving molecules would cool the layer of air to which they belong; but this cooling would rapidly be compensated by radiation and conduction from the surrounding atmosphere; under ordinary circumstances the difference of temperature would scarcely be perceptible, and the uranium would thus appear to perpetually emit rays of energy with no apparent means of restoration.

The total energy of both the translational and internal motions of the molecules locked up in quiescent air at ordinary pressure and temperature is about 140,000 foot pounds in each cubic yard of air. Accordingly the quiet air within a room 12 feet high, 18 feet wide, and 22 feet long contains energy enough to propel a one horse engine for more than twelve hours. The store drawn upon naturally by uranium and other heavy atoms only awaits the touch of the magic wand of science to enable the twentieth century to cast into the shade the marvels of the nineteenth.

While placing before you the labors and achievements of my comrades in science I seize this chance of telling you of engrossing work of my own on the fractionation of yttria, to which for the last eighteen years I have given ceaseless attention. In 1883, under the title of "Radiant Matter Spectroscopy," I described a new series of spectra produced by passing the phosphorescent glow of yttria, under molecular bombardment in vacuo, through a train of prisms. The visible spectra in time gave up their secrets, and were duly embalmed in the Philosophical Transactions. At the Birmingham meeting of the British Association in 1886 I brought the subject before the Chemical Section, of which I had the honor to be president. The results led to many speculations on the probable origin of all the elementary bodies—speculations that for the moment I must waive in favor of experimental facts.

There still remained for spectroscopic examination a long tempting stretch of unknown ultra-violet light, of which the exploration gave me no rest. But I will not now enter into details of the quest of unknown lines. Large quartz prisms, lenses, and condensers, specially sensitized photographic films capable of dealing with the necessary small amount of radiation given by feebly phosphorescing substances,* and above all tireless patience in collating and interpreting results, have all played their part. Although the research is incomplete, I am able to announce that among the groups of rare earths giving phosphorescent spectra in the visible region there are others giving well defined groups of bands which can only be recorded photographically. I have detected and mapped no less than six such groups extending to λ 3060.

Without enlarging on difficulties, I will give a brief outline of the investigation. Starting with a large quantity of a group of the rare earths in a state of considerable purity, a particular method of fractionation is applied, splitting the earths into a series of fractions differing but slightly from each other. Each of these fractions, phosphorescing in vacuo, is arranged in the spectrograph, and a record of its spectrum photographed upon a specially prepared sensitive film.

In this way, with different groups of rare earths, the several invisible bands were recorded—some moderately strong, others exceedingly faint. Selecting a portion giving a definite set of bands, new methods of fractionation were applied, constantly photographing and measuring the spectrum of each fraction. Sometimes many weeks of hard experiment failed to produce any separation, and then a new method of splitting up was devised and applied. By unremitting work—the solvent of most difficulties—eventually it was possible to split up the series of bands into various groups. Then, taking a group which seemed to offer possibilities of reasonably quick result, one method after another of chemical attack was adopted, with the ultimate result of freeing the group from its accompanying fellows and increasing its intensity and detail.

As I have said, my researches are far from complete, but about one of the bodies I may speak definitely. High up in the ultra-violet, like a faint nebula in the distant heavens, a group of lines was detected, at first feeble and only remarkable on account of their isolation. On further purification these lines grew stronger. Their great refrangibility cut them off from other groups. Special processes were employed to isolate the earth, and using these lines as a test, and appealing at every step to the spectrograph, it was pleasant to see how each week the group stood out stronger and stronger, while the other lines of yttrium, samarium, ytterbium, etc., became fainter, and at last, practically vanishing, left the sought-for group strong and solitary. Finally, within the last few weeks, hopefulness has emerged into certainty, and I have absolute evidence that another member of the rare earth groups has been added to the list. Simultaneously with the chemical and spectrographic attack, atomic weight determinations were constantly performed.

As the group of lines which betrayed its existence stand alone, almost at the extreme end of the ultra-violet spectrum, I propose to name the newest of the elements Monium, from the Greek $\mu o'\nu o\varsigma$, alone. Although caught by the searching rays of the spectrum, Monium offers a direct contrast to the recently discovered gaseous elements, by having a strongly marked individuality; but although so young and willful, it is willing to enter into any number of chemical alliances.

Until my material is in a greater state of purity I hesitate to commit myself to figures; but I may say that the wave-lengths of the principal lines are 3120 and 3117. Other fainter lines are at 3219, 3064 and 3060. The atomic weight of the element, based on the assumption of R_2O_3, is not far from 118—greater than that accepted for yttrium and less than that for lanthanum.

I ought almost to apologize for adding to the already too long list of elements of the rare earth class—the asteroids of the terrestrial family. But as the host of celestial asteroids, unimportant individually, become of high interest when once the idea is grasped that they may be incompletely coagulated remains of the original nebula, so do these elusive and insignificant rare elements rise to supreme importance when we regard them in the light of component parts of a dominant element, frozen in embryo, and arrested in the act of coalescing from the original protyle into one of the ordinary and law-abiding family for whom Newlands and Mendeleeff have prepared pigeon-holes. The new element has another claim to notice. Not only is it new in itself, but to discover it a new tool had to be forged for spectroscopic research.

Further details I will reserve for that tribunal before whom every aspirant for a place in the elemental hierarchy has to substantiate his claim.

These, then, are some of the subjects, weighty and far-reaching, on which my own attention has been chiefly concentrated. Upon one other interest I have not yet touched—to me the weightiest and the farthest reaching of all.

No incident in my scientific career is more widely known than the part I took many years ago in certain psychic researches. Thirty years have passed since I published an account of experiments tending to show that outside our scientific knowledge there exists a force exercised by intelligence differing from the ordinary intelligence common to mortals. This fact in my life is, of course, well understood by those who honored me with the invitation to become your president. Perhaps among my audience some may feel curious as to whether I shall speak out or be silent. I elect to speak, although briefly. To enter at length on a still debatable subject would be unduly to insist on a topic which—as Wallace, Lodge and Barrett have already shown—though not unfitted for discussion at these meetings, does not yet enlist the interest of the majority of my scientific brethren. To ignore the subject would be an act of cowardice—an act of cowardice I feel no temptation to commit.

To stop short in any research that bids fair to widen the gates of knowledge, to recoil from fear of difficulty or adverse criticism, is to bring reproach on science. There is nothing for the investigator to do but to go straight on, "to explore up and down inch by inch, with the taper his reason;" to follow the light wherever it may lead, even should it at times resemble a will-o'-the-wisp. I have nothing to retract. I adhere to my already published statements. Indeed, I might add much thereto. I regret only a certain crudity in those early expositions which, no doubt justly, militated against their acceptance by the scientific world. My own knowledge at that time scarcely extended beyond the fact that certain phenomena new to science had assuredly occurred, and were attested by my own sober senses, and better still, by automatic record. I was like some two-dimensional being who might stand at the singular point of a Riemann's surface, and thus find himself in infinitesimal and inexplicable contact with a plane of existence not his own.

I think I see a little further now. I have glimpses of something like coherence among the strange elusive phenomena; of something like continuity between those unexplained forces and laws already known. This advance is largely due to the labors of another association of which I have also this year the honor to be president—the Society for Psychical Research. And were I now introducing for the first time these inquiries to the world of science, I should choose a starting-point different from that of old. It would be well to begin with telepathy; with the fundamental law, as I believe it to be, that thoughts and images may be transferred from one mind to another without the agency of the recognized organs of sense—that knowledge may enter the human mind without being communicated in any hitherto known or recognized ways.

Although the inquiry has elicited important facts with reference to the mind, it has not yet reached the scientific stage of certainty which would entitle it to be usefully brought before one of our sections. I will therefore confine myself to pointing out the direction in which scientific investigation can legitimately advance. If telepathy take place, we have two physical facts—the physical change in the brain of A, the suggester, and the analogous physical change in the brain of B, the recipient of the suggestion. Between these two physical events there must exist a train of physical causes. Whenever the connecting sequence of intermediate causes begins to be revealed, the inquiry will then come within the range of one of the sections of the British Association. Such a sequence can only occur through an intervening medium. All the phenomena of the universe are presumably in some way continuous, and it is unscientific to call in the aid of mysterious agencies when with every fresh advance in knowledge it is shown that ether vibrations have powers and attributes abundantly equal to any de-

*In this direction I am glad to acknowledge my indebtedness to Dr. Schuman, of Leipzig, for valuable suggestions and detail of his own apparatus, by means of which he has produced some unique records of metallic and gaseous spectra of lines of short wave length.

mand—even to the transmission of thought. It is supposed by some physiologists that the essential cells of nerves do not actually touch, but are separated by a narrow gap which widens in sleep, while it narrows almost to extinction during mental activity. This condition is so singularly like that of a Branly or Lodge coherer as to suggest a further analogy. The structure of brain and nerve being similar, it is conceivable there may be present masses of such nerve coherers in the brain whose special function it may be to receive impulses brought from without through the connecting sequence of ether waves of appropriate order of magnitude. Roentgen has familiarized us with an order of vibrations of extreme minuteness compared with the smallest waves with which we have hitherto been acquainted, and of dimensions comparable with the distances between the centers of the atoms of which the material universe is built up; and there is no reason to suppose that we have here reached the limit of frequency. It is known that the action of thought is accompanied by certain molecular movements in the brain, and here we have physical vibrations capable from their extreme minuteness of acting direct on individual molecules, while their rapidity approaches that of the internal and external movements of the atoms themselves.

Confirmation of telepathic phenomena is afforded by many converging experiments, and by many spontaneous occurrences only thus intelligible. The most varied proof, perhaps, is drawn from analysis of the sub-conscious workings of the mind, when these, whether by accident or design, are brought into conscious survey. Evidence of a region below the threshold of consciousness has been presented, since its first inception, in the Proceedings of the Society for Psychical Research, and its various aspects are being interpreted and welded into a comprehensive whole by the pertinacious genius of F. W. H. Myers. Concurrently, our knowledge of the facts in this obscure region has received valuable additions at the hands of laborers in other countries. To mention a few names out of many, the observations of Richet, Pierre Janet, and Binet (in France), of Breuer and Freud (in Austria), of William James (in America) have strikingly illustrated the extent to which patient experimentation can probe subliminal processes, and can thus learn the lessons of alternating personalities and abnormal states. While it is clear that our knowledge of subconscious mentation is still to be developed, we must beware of rashly assuming that all variations from the normal waking condition are necessarily morbid. The human race has reached no fixed or changeless ideal; in every direction there is evolution as well as disintegration. It would be hard to find instances of more rapid progress, moral and physical, than in certain important cases of cure by suggestion—again to cite a few names out of many—by Liébeault, Bernheim, the late Auguste Voisin, Berillon (in France), Schrenck-Notzing (in Germany), Forel (in Switzerland), Van Eeden (in Holland), Wetterstrand (in Sweden), Milne-Bramwell and Lloyd Tuckey (in England). This is not the place for details, but the vis medicatrix thus evoked, as it were, from the depths of the organism, is of good omen for the upward evolution of mankind.

A formidable range of phenomena must be scientifically sifted before we effectually grasp a faculty so strange, so bewildering, and for ages so inscrutable, as the direct action of mind on mind. This delicate task needs a rigorous employment of the method of exclusion—a constant setting aside of irrelevant phenomena that could be explained by known causes, including those far too familiar causes, conscious and unconscious fraud. The inquiry unites the difficulties inherent in all experimentation connected with mind, with tangled human temperaments and with observations dependent less on automatic record than on personal testimony. But difficulties are things to be overcome even in the elusory branch of research known as experimental psychology. It has been characteristic of the leaders among the group of inquirers constituting the Society for Psychical Research to combine critical and negative work with work leading to positive discovery. To the penetration and scrupulous fair-mindedness of Prof. Henry Sidgwick and of the late Edmund Gurney is largely due the establishment of canons of evidence in psychical research, which strengthen while they narrow the path of subsequent explorers. To the detective genius of Dr. Richard Hodgson we owe a convincing demonstration of the narrow limits of human continuous observation.

It has been said that "Nothing worth the proving can be proved, nor yet disproved." True though this may have been in the past, it is true no longer. The science of our century has forged weapons of observation and analysis by which the veriest tyro may profit. Science has trained and fashioned the average mind into habits of exactitude and disciplined perception, and in so doing has fortified itself for tasks higher, wider, and incomparably more wonderful than even the wisest among our ancestors imagined. Like the souls in Plato's myth that follow the chariot of Zeus, it has ascended to a point of vision far above the earth. It is henceforth open to science to transcend all we now think we know of matter and to gain glimpses of a profounder scheme of cosmic law.

An eminent predecessor in this chair declared that "by an intellectual necessity he crossed the boundary of experimental evidence, and discerned in that matter which we, in our ignorance of its latent powers, and notwithstanding our professed reverence for its Creator, have hitherto covered with opprobrium, the potency and promise of all terrestrial life." I should prefer to reverse the apophthegm, and to say that in life I see the promise and potency of all forms of matter.

In old Egyptian days a well-known inscription was carved over the portal of the temple of Isis: "I am whatever hath been, is, or ever will be; and my veil no man hath yet lifted." Not thus do modern seekers after truth confront Nature—the word that stands for the baffling mysteries of the universe. Steadily, unflinchingly, we strive to pierce the inmost heart of Nature, from what she is to reconstruct what she has been, and to prophesy what she yet shall be. Veil after veil we have lifted, and her face grows more beautiful, august, and wonderful with every barrier that is withdrawn.

Valuable Books.

Acetylene. Lighting by Acetylene Generators, Burners, and Electric Furnaces. By Wm. E. Gibbs, M.E. 12mo, cloth, 141 pages, 66 illustrations. New York, 1898.....$1 50

Acoustics. Architectural Acoustics; or, The Science of Sound Application Required in the Construction of Audience Rooms. By Eugene Henri Kelly. 8vo, half leather, 111 pages, illustrated. Buffalo, 1898.....$3 50

Architecture. Architectural Drawing for Mechanics. By I. P. Hicks. A comprehensive Treatise on Architectural Drawing for Building Mechanics, showing the learner how to proceed step by step in every detail of the work. Square 12mo, cloth, 6 illustrations, 94 pages. New York.....$1 00

Assaying. A Manual of Assaying Gold, Silver, Lead, Copper. By Walter Lee Brown. Seventh edition. 12mo, cloth, 535 pages, illustrated. Chicago.....$2 50

Bicycle Repairing. A Manual Compiled from Articles in The Iron Age. By S. D. V. Burr. Fourth edition, revised and enlarged. 8vo, cloth, 208 pages, illustrated. New York, 1898. $1 00

Birds. Nests and Eggs of North American Birds. By Oliver Davie. Fifth edition, revised, augmented, and illustrated. 8vo, cloth, 550 pages. Cleveland, 1898.....$2 25

Boilers and Furnaces considered in their relations to Steam Engineering. By Wm. M. Barr. With upward of 450 engravings of Boiler and Furnace Details from Drawings executed expressly for this work. 8vo, cloth, 405 pages. Philadelphia, 1898 ....$3 00

Bridges. Theory and Calculation of Cantilever Bridges. By R. M. Wilcox. 16mo, boards, 108 pages. New York, 1898....$0 50

Building Construction and Superintendence. By F. E. Kidder. Part II., Carpenter's Work. 324 illustrations, 544 pages, 8vo, cloth. New York, 1898.....$4 00

Calculator. Hopp's Commercial Calculator. A Practical Arithmetic for Practical Purposes. Containing a complete System of Useful, Accurate, and Convenient Tables and Simple, Short, and Practical Methods of Rapid Calculation. By C. Hopp. 16mo, pocket form, 128 pages.....$0 50

Cattle Feeding. Feeds and Feeding. A Handbook for the Student and Stockman. By W. A. Henry. 8vo, cloth, 656 pages. 1898.....$2 00

Cements. American Cements. A treatise on the nature and properties of natural and artificial hydraulic cements, together with an exhaustive research into the analytical and scientific branches of the subject. By Uriah Cummings. Illustrated, 16mo, cloth. Boston, 1898.....$3 00

Chemistry. A Textbook of Chemistry Intended for the Use of Pharmaceutical and Medical Students. By Samuel P. Sadtler and Henry Trimble. Second Revised and Enlarged Edition, in two volumes. Vol. I., General Chemistry. 8vo, cloth, 842 pages, illustrated. Philadelphia, 1898.....$4 00

Compressed Air. Practical Information upon Air Compression and the Transmission and Application of Compressed Air. By Frank Richards. 12mo, cloth, 203 pages, illustrated. New York.....$1 50

Our large Catalogue of American and Foreign Scientific and Technical Books, embracing more than Fifty different subjects, and containing 116 pages, will be mailed, free, to any address in the world.

Any of the foregoing Books mailed, on receipt of price, to any address. Remit by Draft, Postal Note, Check, or Money Order, to order of

MUNN & CO.,
361 Broadway, New York.

SUITABLE FOR YOUNG OR OLD PEOPLE.

MAGIC

Stage Illusions and Scientific Diversions, Including Trick Photography.

By ALBERT A. HOPKINS,
Editor of the "Scientific American Cyclopedia of Receipts, Notes and Queries," etc.

This unique work appeals to the professional and the amateur alike and will prove a welcome addition to any library. The illusions are illustrated by the highest class of engravings.

Great attention is paid to the exposés of large and important illusions; these have been in many cases furnished by the prestidigitateurs themselves. Some of the most important tricks of Robert Houdin, Bautier de Kolta, Heller, and Herrmann are explained. Conjuring is not neglected, a selection of some of the best known of these tricks having been made. Fire-eaters, sword-swallowers, ventriloquists, shadowgraphists, all come in for a share of attention, while the chapter on "Mental Magic" describes simple means of performing second-sight.

Such entertainments as cycloramas, fireworks, etc., are also treated, and all well illustrated with original engravings. Automata and curious toys are then described.

This work is acknowledged by the **Profession** to be

THE STANDARD WORK ON MAGIC.

The section devoted to Photographic Diversions is very complete, giving the method of producing astonishing trick photographs. The method of taking and projecting moving photographs is described in detail—the vitascope, the cinematograph, the mutoscope, and the mutograph being fully described and illustrated. This work cannot fail to be of interest to young and old, and there is hardly any one who is in any way interested in either science or magic to whom it will not appeal. It is beautifully printed and is very attractively bound in special cloth, with stamp in colored inks.

SECOND EDITION NOW READY.

568 Pages. 420 Illustrations.
Price, by mail to any part of the world, $2.50.
An Illustrated Circular sent on Application.

THE SCIENTIFIC AMERICAN

CYCLOPEDIA of RECEIPTS, NOTES and QUERIES

EDITED BY ALBERT A. HOPKINS.

12,500 Receipts, 708 Pages.

Price, $5 in cloth; $6 in sheep; $6.50 in half morocco; Postpaid

This splendid work contains a careful compilation of the most useful Receipts and Replies given in the Notes and Queries of correspondents as published in the SCIENTIFIC AMERICAN during the past fifty years; together with many valuable and important additions.

Over twelve thousand selected receipts are here collected; nearly every branch of the useful arts being represented. It is by far the most comprehensive volume of the kind ever placed before the public.

The work may be regarded as the product of the studies and practical experience of the ablest chemists and workers in all parts of the world; the information given being of the highest value, arranged and condensed in concise form, convenient for ready use.

Almost every inquiry that can be thought of, relating to formulæ used in the various manufacturing industries, will here be found answered.

Those who are in search of independent business or employment, relating to the home manufacture of salable articles, will find in it hundreds of most excellent suggestions.

MUNN & CO., Publishers, 361 Broadway, N. Y.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers, 361 Broadway, New York.

TABLE OF CONTENTS.

PAGE

I. ARCHÆOLOGY.—The Excavations at Corinth.—By RUFUS B. RICHARDSON.....19081

II. ASTRONOMY.—The Astronomy of the "Canterbury Tales."—By E. WALTER MAUNDER.....19084

III. ATHLETICS.—The Milon Trio, Modern Athletes.—1 illustration.....19079

IV. CHEMISTRY.—A New Gas.—By C. F. BRUSH.....19086
Osmium.....19086
Discovery of New Chemical Elements.—By CLEMENS WINKLER.....19084

V. DENTISTRY.—Aluminum Crowns.—By A. E. PRESTON.....19081

VI. ELECTRICITY.—Electroplating on Wood.—By C. F. BURGESS.....19085

VII. ETHNOLOGY.—Ghost Dance. I.—4 illustrations.....19071

VIII. LITERATURE.—The Astronomy of the "Canterbury Tales." —By E. WALTER MAUNDER.....19084

IX. MEDICINE.—Relative Value as Disinfectants, Antiseptics, and Deodorizers of Reputed Antiseptics.....19084

X. METEOROLOGY.—A Chimney Struck by Lightning.—1 illustration.....19074

XI. MISCELLANEOUS.—Pontoon for Use on Narrow Rivers.—3 illustrations.....19082
Engineering Notes.....19077
Miscellaneous Notes.....19077
Selected Formulæ.....19077

XII. NATURAL HISTORY.—The Beaver.—1 illustration.....19075

XIII. PHYSICS.—Radiographic Novelties.—3 illustrations.....19085

XIV. SCIENCE.—Inaugural Address by Sir WILLIAM CROOKES, F.R.S., V.P.C.S., President of the British Association.....19084

XV. STEAM ENGINEERING.—Setting Back Bulges in Furnaces.—By a BOILER INSPECTOR.—1 illustration.....19082

XVI. TRAVEL AND EXPLORATION.—Foreigners in Japan.—By R. VAN BERGEN.....19079

SPECIAL NAVAL SUPPLEMENT, No. 1165,

contains a historical review of the modern United States navy, the classification of the various forms of war vessels and nearly one hundred illustrations, including details of construction of such vessels not found in any other publication. A map of Cuba printed in five colors accompanies it. Price, 25 cents. Single copies sent by mail in United States, Canada and Mexico. Foreign countries, 8 cents extra.

MUNN & CO., 361 Broadway, New York.

THE SCIENTIFIC AMERICAN

Army and Coast Defence Supplement

GUNS, ARMOR AND FORTIFICATIONS.

The present number is uniform in size with our Special Navy Supplement, which has attracted such wide attention. It treats of guns and gun carriages for Army and Navy use and Coast Defence, including disappearing gun carriages, rapid fire guns, machine guns, mortars, etc., with special reference to their construction and operation. This section of the paper is profusely illustrated with drawings which enable their operation to be readily understood by the lay reader. The subject of projectiles, powders, gun cotton, etc., is also fully treated; range finders, torpedoes, submarine mines and armor are all fully described and illustrated. There is also a section devoted to the small arms of the Army and Navy, together with an account of the organization of the Army, with fine engravings of prominent Generals. Never before have these subjects been treated in such a popular way. The illustrations number over 100 and include a magnificent double page Supplement of our largest battleship, the "Iowa." The whole is enclosed in a handsome cover, showing a large coast defence gun in action.

Price by mail, 25 cents; to foreign countries, 35 cents.

MUNN & CO., Publishers, 361 Broadway, New York.

BUILDING EDITION

OF THE

SCIENTIFIC AMERICAN.

Those who contemplate building should not fail to subscribe.

ONLY $2.50 A YEAR.

Semi-annual bound volumes $2.00 each, yearly bound volumes $3.50 each, prepaid by mail.

Each number contains elevations and plans of a variety of country houses; also a handsome

COLORED PLATE.

MUNN & CO., 361 Broadway, New York.

PATENTS!

MESSRS. MUNN & CO., in connection with the publication of the SCIENTIFIC AMERICAN, continue to examine improvements, and to act as Solicitors of Patents for inventors.

In this line of business they have had *fifty years' experience*, and now have *unequaled facilities* for the preparation of Patent Drawings, Specifications, and the prosecution of Applications for Patents in the United States, Canada, and Foreign Countries. Messrs. Munn & Co. also attend to the preparation of Caveats, Copyrights for Books, Trade Marks, Reissues, Assignments, and Reports on Infringements of Patents. All business intrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent free of charge, on application containing full information about Patents and how to procure them; directions concerning Trade Marks, Copyrights, Designs, Patents, Appeals, Reissues, Infringements, Assignments, Rejected Cases, Hints on the Sale of Patents, etc.

We also send, *free of charge*, a Synopsis of Foreign Patent Laws showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,
361 Broadway, New York

BRANCH OFFICES.—No. 625 F Street, Washington, D. C.

1898.

ent.

r.

s in any
dollars a

from the
. Price,

ean like-
yearly,
or $3.00

AMERI-
SUPPLE-

nts, and

v York.

PAGE
ES B.
..... 19070
"—By
..... 19074
stra-
..... 19079
..... 19080
KLES 19081
..... 19083
ESS.. 19086
..... 19071
les." 19076
, and
..... 19084
stra-
..... 19074
rs.—3
..... 19088
..... 19087
..... 19077
..... 19078
..... 19075
KES.
..... 19094
es.—
..... 19093
—By
..... 19079

55,

e classi-
l Illustra-
d in any
panies $3.
nada and

York.

ment

Supple-
and gen
sappear-
h special
he paper
ion to be
powders.
bmarine
is also a
her with
wings of
reated in
e a mag-
" lower
defense

ew York.

ON

fail to

yearly

of a

rk.

S!

ublica-
examine
for in-

nd new
Specifi-
Unites
tend to
rinciples.
ees in-
reason-

iforma-
Trade
ments,

howing
ries of